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CROP MANAGEMENT AND SOIL CONSERVATION

Second Edition

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To the future farmers of America, in whose keeping largely rests the future of our country, this book is dedicated.

PREFACE

It is the primary object of this book in dealing with specific crops to present in a simple way the major operations that will enable the grower to grow and market his crops successfully. Practices that are effective in reducing the cost of production, increasing yields, improving crop qualities, maintaining fertility, and marketing efficiently are given particular emphasis.

The achievements of recent years in developing a national program directed toward the production of increased food during the war years and post-war period of world-wide starvation, the balancing of crop production, and the conservation of soils are given an important place in this book.

The public mind, as never before, is aware of the fact that exhaustive farming at low prices for staple crops has cost the nation dearly in loss of soil fertility. The individual farmer knows that he must receive a price for his products above the cost of production in order to be able to maintain or improve fertility by buying the seed of leguminous crops and grasses, applying lime and fertilizer where needed, and employing sound rotation practices.

It is hoped that this book will aid individual growers in improving their crop rotations and increasing their profits through efficient production methods. It is also the desire of the authors and editors that the importance of balancing production in accordance with market demands, protecting soils from erosion losses and depletion by exhaustive farming, and the need of returning fertility to offset drafts of war and post-war production will be thoroughly understood by all who read this book.

THE EDITORS AND AUTHORS

SUGGESTIONS TO THE TEACHER

by

THE AUTHORS AND EDITORS

The function of the teacher is to guide the work of students. It is his privilege to inspire and challenge students to make the most of their opportunities. Teaching is not a job of "peddling" subject matter to unwilling pupils, but it is the creative undertaking of formulating an environment or learning situation in which each individual finds satisfaction in intellectual achievement. The art of the teacher is expressed in his ability to stir the fundamental human urges that are the basis of interest. Create a sound interest in a worthy objective and the work of teaching is more than half done.

This book has been written not only from the standpoint of presenting information having to do with crop management and soil conservation but also with the thought of organizing it in a reasonably satisfactory manner for teaching purposes. It is assumed that all or a large part of a school year is to be devoted to the development in individual students of particular abilities in the field of crop management and soil conservation. In addition to this period of intensive training, it is expected that students will be under the direction of the teacher in conducting supervised practice and project work closely related to the school work. Such a program calls for a broad plan of action for students and teacher to follow in achieving their purposes.

Plan of Instruction. The following general plan is suggested with the thought that it may correlate the plan of the book with a program of instruction. The plan is presented as a general outline with the expectation that teachers will

modify it to meet their needs and that details will be added according to the local situation.

I. Develop in students an appreciation of the importance of efficiency in crop management and soil conservation.

Spend the first class period in helping students to analyze the purposes of devoting time to work in the field of crop production and soil conservation. This may be done by placing upon the blackboard such a question as, "Should 'Future Farmers' spend time in studying crop management and soil conservation?" A group of farm boys under the direction of a good teacher will soon formulate statements suitable for recording upon the blackboard. Analyze the question from the standpoint of the individual student, and then enlarge upon it until problems of national policy have been reached. The first chapter of this book provides useful information concerning the importance to the nation of efficient soil conservation and crop management.

A tip to the teacher—answer the question to your own satisfaction before attempting to direct a discussion concerning it.

II. Develop an understanding of the relationship of Crop Management and Soil Conservation on a given farm to the whole farming program of that farm.

All too often teachers cause students to deal with an enterprise or phase of crop production as if it were a detached portion of the farming program. For example, pastures should not be dealt with as pastures alone, but from the standpoint of developing a pasture program to meet the needs for pasture in the plan of farm management. Do not teach alfalfa, but guide students in considering the production of alfalfa to meet the needs for feeding livestock. Constant attention should be given to interrelationships in order to develop in students a sense of perspective or balance. A farmer has to be concerned with the *parts of a whole* and not *just the parts*.

A beginning toward the achievement of this point of view may be made by a class period devoted to developing the diagram suggested in Chapter II. The diagram is useful in de-

veloping an understanding of the part played by crop management and soil conservation in a total farming program.

III. Discuss with students the possibilities for supervised practice programs or projects and for planning crop management and soil conservation programs for their home farms.

Devote a class period or two to outlining the major problems in crop management and soil conservation that exist upon the home farms of students. Help students to see not only that a well-chosen program of supervised practice or project work can make definite improvement in the farming practices on their home farms, but that the experiences of carrying out such programs are extremely valuable in developing farming ability. Guide students in making a list of possible opportunities, such as the establishment of a legume hay crop, the testing of certain cover and green-manuring crops, improvements in pastures, the introduction of new seed, the growing of certain cash crops, the introduction of improved fertilizer practices, eradication of noxious weeds, the testing of certain soil-conservation practices, or the planting of certain areas to trees.

It is not expected that all students will make final decisions when the suggestions for supervised practice programs are first presented, but it is important to present such proposals within the first few days of the school year in order that specific plans may be matured at an early date. Guide students in planning long-time programs that are a real challenge.

IV. Plan the Program of Instruction with Students.

If the teacher has been successful in directing the thinking of students during the first few class-discussion periods, as suggested under headings I, II, and III, each student will have a definite realization of certain goals or objectives to be achieved and of definite problems to be solved. In other words, the teacher must arouse in students a distinct feeling of need for developing particular abilities in the field of crop management and soil conservation.

Present to students such a question as, "How shall we

organize our program of instruction?" *It is expected that teachers will have definite plans in mind,* but there should be a pooling of the teacher's ideas with those of the students. From such a procedure should arise definite working plans that are understood and appreciated by both students and teacher. Such plans may follow the general procedures suggested under headings V, VI, and VII which follow.

V. Spend a few periods of class time in gathering information about farming conditions and practices on home farms or from a farm which has been selected for intensive study.

Real farm problems arise from actual farm situations; therefore, it is important to know farm conditions as they are. For example, it is much more advantageous to attack an actual problem of how to establish a vigorous stand of alfalfa than to study alfalfa.

Plan a number of field trips to collect materials and information to be used in the promotion of effective classroom work. See Chapter II for definite suggestions.

VI. Devote a large portion of the time during the school year to developing in students an understanding of certain basic facts and principles having to do with crop management and soil conservation.

Many farmers farm by thumb rules or, in other words, follow certain procedures and practices without knowing why. Certain practices may even be guided by superstitions. It seems important to suggest, for example, that the inoculation of legumes should mean more than merely following the directions on the bottle. It may seem sensible to save seed from a field of hybrid corn unless one understands what happens to succeeding crops. The teacher should strive to introduce practical problem situations and then guide students in the development of an understanding of the facts and principles which are fundamental in the solution of the problems.

Chapters III to XVIII have been especially designed to aid in an understanding of fundamental facts and principles relating particularly to crop management and soil conservation.

See suggestions at the end of each chapter for help in planning the instruction.

VII. Completing and carrying out plans for supervised practice and farming programs having to do with crop management and soil conservation.

It is suggested that teachers and students give attention to supervised practice programs early in the school year. At every opportunity the teacher should push forward the plans for this phase of the instructional program. Efficiency in a supervised practice program in crops and soils may call for certain jobs to be performed early in the school year in preparation for the coming growing season. Certain modifications in the teaching program should be made to care for such jobs.

When the instructional program, suggested under heading VI, has been completed, it is suggested that the teacher guide students in completing their plans for supervised practice and farming programs. Make a job analysis of each enterprise or phase of the crop management and soil conservation programs with which the students are concerned. In making the managerial decisions and in carrying out the operative jobs, use the facts and principles which have been developed in Part I of the book, together with the specific crop information found in Part II of the book.

It is expected that the remainder of the school year will be devoted to the completion of plans for carrying out the proposed supervised practice and farming programs relating to crop management and soil conservation.

Chapter XVIII furnishes suggestions for this part of the instructional program. See diagram of suggested plan of instruction on page xvi.

Reference Material. Since it is obviously impossible to include in the text all the pertinent information dealing with crop management and soil conservation, especially as it may apply to specific local situations, teachers are urged to secure reference books and bulletins to use in connection with this text.

General Plan for Instruction in Crop Management and Soil Conservation

I. Develop in students an appreciation of the importance of efficiency in crop management and soil conservation. Chapter I.

II. Develop an understanding of the relationship of "Crop Management and Soil Conservation" upon a given farm to the whole farming program of that farm. Chapter II.

III. Discuss with students the possibilities for supervised practice programs or projects and for planning crop management and soil conservation programs for their home farms. Chapter II.

IV. Plan the program of instruction with students. Use a class period or two for this work. Chapter II.

V. Make farm surveys to gather information about farming conditions and practices on home farms and in the community. Chapter II.

VI. Devote a large portion of the time during the school year to developing in students an understanding of certain basic facts and principles of crop management and soil conservation.

Chapters III to XVII, inclusive, provide information and suggestions for solving the problems which contribute to an understanding of the principles of crop management and soil conservation.

VII. Complete specific plans for student programs of supervised practice or project work.

Make a job analysis of each farm enterprise or phase of crop management and soil conservation which students expect to carry out. Use the facts and principles developed under VI above together with the information found in Part II of the text in solving the managerial and operative problems revealed by the job analyses.

See Chapter XVIII.

—Period of Instruction or School Year—

Note: Whenever necessary give time to the specific development of the project and supervised practice programs of students. Such work needs to be integrated with the program of instruction.

College or special texts in the field of crops and soils will be found especially useful to the teacher, as they often contain summaries of experiment station data from many different sources. If possible, secure the books listed as chapter references.

Bulletins from the United States Department of Agriculture and the state agricultural experiment stations and agricultural extension services should be procured. Some of the bulletins will be valuable only to the teacher, but others, if it is possible to obtain them in sufficient quantity, will be valuable for both teacher and students.

Types of Thinking to Stimulate. Too much emphasis has been placed upon the memorizing of subject matter to the exclusion of developing habits of effective thinking. If facts are needed and used in a process of effective thinking, their memorization becomes a by-product of the process.

Analytical Thinking. Whenever possible, give students the opportunity to "think things apart." Do not analyze problems for students but guide them in making their own analyses. Much of the value of the job-analysis procedure lies in training students to make their own analyses of enterprises rather than in presenting them with detailed analyses.

Judicial Thinking. Do not make decisions for students but guide and correct them in making their own decisions. The processes of reflective thinking call for a weighing of relative values and the formulation of an opinion or decision in the light of the facts. Develop in students an understanding of the difference between snap judgments based upon superficial evidence and judgments made after careful consideration of all the available facts.

Creative Thinking. Whenever an individual, as the result of his own thinking, formulates a plan, creative thinking has taken place.

Provide opportunity for students to develop and execute their own plans as far as possible. A plan submitted by a student to a teacher for approval leads to greater human

development than a plan submitted by a teacher for students to follow.

Presenting Tabular Information. Much important information concerning crop management and soil conservation is available at agricultural experiment stations. Much of this information is in the form of statistical tables. Students of agriculture need to use such information, but much of its value is often lost because of poor presentation of data. To ask students to memorize the facts in tables is one of the surest ways of losing the interest students have; such a procedure may cause an active dislike for the whole teaching program.

One of the best methods of presenting tabular information to students of agriculture is on the blackboard. Many times, however, the regular blackboard space is limited; it is often necessary for teachers to erase from blackboards material which has been used and to spend considerable time in copying additional material while the class waits. The continuity of instructional procedure is broken, and classes often become restless while they wait for the information to be made ready for use.

These problems may be overcome if a supply of paper blackboard is prepared. Paint heavy brown wrapping paper with one coat of blackboard dressing. The material dries rapidly, and within twenty-four hours the paper blackboard is ready for use.

Before writing upon such a blackboard, rub the surface with an eraser impregnated with chalk dust, to cover the black surface with a coating of the dust. Clean off this coating with a piece of cheesecloth, and the surface is ready to be used like any blackboard. It is rather difficult to erase marks from the blackboard unless the surface has first been covered with a light coating of chalk dust.

Tables in blackboard size for class work are commonly displayed in complete form, but a more effective method is to present such information with the most significant portions left out, so that the missing information may be filled in as

the ideas relating to the table are developed. When a complete table is displayed to a group of students, it is extremely difficult to control attention because the tendency is to read the information rather than to follow the remarks made by the teacher. When the significant parts of the table have been omitted, the information has no meaning for the reader. The teacher can develop the information point by point, filling in the missing information as needed. The paper blackboard can be used to great advantage because the desired number of partial tables may be made ready for the class meetings.

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PART I

CHAPTER I

BALANCING CROP PRODUCTION AND MAINTAINING FERTILITY

"We must consider . . . not merely how to produce, but also how production affects the producer." THEODORE ROOSEVELT

The Land of America—Our Greatest Heritage. We are the fortunate possessors of over 610,000,000 acres of tilled or tillable soil available for growing the crops and livestock that feed and clothe the nation, provide raw materials for manufacture, and supply export demands. This vast land area includes the world's greatest region of productive soils located under temperate climatic conditions—the Corn Belt of our Midwest. In our Southern States a great range of soils produces crops under semi-tropical conditions. In our Northern States, and at higher altitudes, along our Appalachian and Rocky Mountain ranges, the grass and legume crops, grains, and root crops that are basic to dairy and animal production are extensively grown. In times of peace, the products of our soils are fundamental to our health, prosperity and peace; in times of war, they constitute a primary source of our strength.

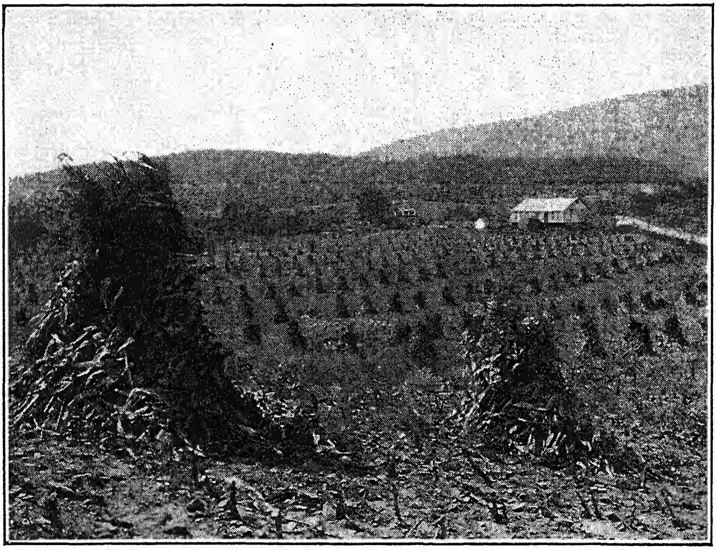
The wide variety of climatic and soil conditions and the tempering influence of the oceans along our coast lines and of great inland bodies of water, such as our Great Lakes, provide the natural conditions for highly specialized field and truck crop, fruit, livestock, and poultry production.

Our extensive area of tillable land varies greatly in the

character of the soil, ranging from heavy soils, such as clays and clay loams, to lighter soil classes, such as the sandy loams, sandy soils, and muck soils. In the Northern States and over much of the Corn Belt, glaciers of past ages left a fertile drift soil, generally level or gently rolling. This glaciated country is traversed by frequent streams draining unusually broad glacial valleys, and dotted with fresh-water lakes of varying size—a well-watered region of grassland and woodland that includes the most fertile corn-growing, wheat-growing, and pasture and hay-producing regions of the world. This region produces annually far more food than is required by its population and, during World War I and World War II, vastly increased production of corn and wheat, hogs and cattle, dairy and poultry products contributed largely to the basic resources of food and products for manufacture needed in winning those great conflicts. After World War II, continued high production from this fertile region was a major factor in checking the ravages of world-wide famine.

The North Eastern region is characterized by its highly developed dairy and poultry industries and specialized truck, potato, fruit, and seed crops. Pasture improvement has reached high development. This region includes great centers of population that offer exceptional marketing opportunities. The country is interspersed with lake, streams, woodland, and mountains and provides excellent living conditions and varied interests.

Our Southern and Gulf region, a country of mild and equable climate and well-distributed rainfall, includes within its borders the greatest cotton-producing lands of the world, contributing annually about three-fourths of the world's supply of cotton. This region is also remarkable for the high percentage of its people that live on the land, producing on the farm a large share of food consumed by the farm family. To the south of this region, in Florida, and bordering the Gulf of Mexico in southern Texas and in southern California, there has been the world's greatest development in the production of



Good farming practices have maintained fertility for over two centuries on the limestone valleys of Pennsylvania and Maryland. *Extension Service, U.S.D.A.*

The soils of our Corn Belt represent the world's greatest area of fertile soil located under climatic conditions highly favorable to crop and livestock production. *Indiana Exp. Sta.*

oranges, grapefruit, lemons, other semi-tropical plants, and winter truck crops. The development in the agriculture of this region is capable of much greater expansion.

The great grass and small grain regions of our West and Northwest have provided conditions suitable for unrivaled

Michigan

A farming country in the making—newly cleared land, charged with the humus accumulated by centuries of forest, produces excellent crops for several generations with little attention to fertility maintenance.

livestock and grain-farming developments and our Pacific Northwest, a region of diversified agriculture, has become famous for its high yields of wheat per acre, its production of apples, and the production of high-quality seed of field and vegetable crops.

We Are the Caretakers of Our Soils. The possession of this magnificent heritage, although assuring us of national prosperity, carries with it a direct obligation to conserve and, if possible, to improve our land. Several centuries of farm production have contributed to the building up of our nation, but the methods employed have seriously impaired great areas

of our soil. H. H. Bennett, chief of the Soil Conservation Service of the United States Department of Agriculture, in his book on soil conservation published in 1939, estimates that more than 50,000,000 acres, or nearly one-sixth of our cultivated land, have been so injured by soil depletion and erosion that this area, equivalent in size to several of our Midwestern States, has been ruined as productive land. An additional 50,000,000 acres have been seriously damaged. More than 100,000,000 acres, or one-third of our cultivated lands are more or less impaired by erosion and fertility extraction.

It is apparent that our farming practices on many farms must be adjusted to protect our basic heritage from further loss and to correct the damage done during our pioneer development. No longer can American farmers afford to sell crops at prices that will not pay for the return of the elements of fertility taken from the land and for the employment of sound farming systems. Only by the widespread use of proper erosion-prevention and fertility-maintaining practices can our soil resources be expected to provide amply for the nation's needs and continuing progress.

Chas. E. Kellogg, chief of the Soil Survey Division, U.S.D.A., states as follows:

> Although the productivity of the soils of the United States is still high, deterioration has been significant during the past one hundred years, and the future of our agriculture is unpleasant to contemplate while this tendency continues unchecked. . . .
>
> Perhaps we are at a turning point. During the immediate past many citizens, and especially those concerned directly with agriculture, have become aware of the problem. It has been found useful and practical to employ cooperative devices, both locally and nationally, to establish a better adjustment between the people and their land. . . . The ends of conservation, of both soil and people, can thus be realized.

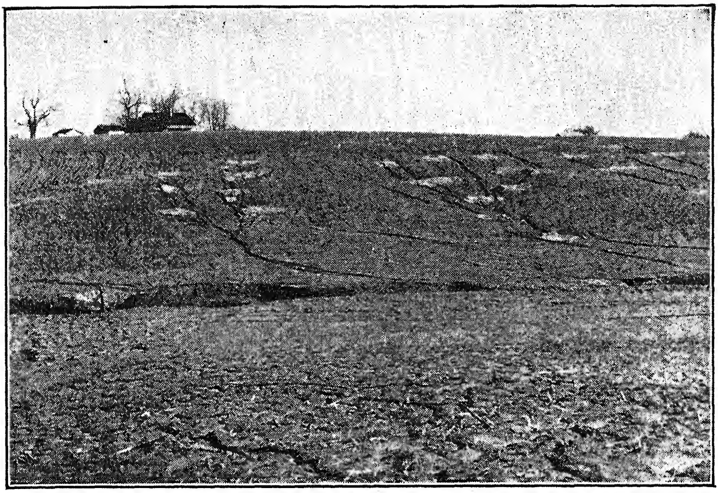
The Nation Pays Dearly for the War Years. During World War I, under the pressure for utmost production of grains, meat, and cotton, more than 40,000,000 acres of land, formerly

in grasses and legumes, were added to our land devoted to soil-depleting crops. After World War I, production continued in this vast area in the face of disappearing export demand. Prices for our basic commodity crops were forced down, far below the cost of production. Under conditions that encouraged continued production of cash crops, vast surpluses developed.

From 1921 until the depth of the depression in 1932, American agriculture continued to decline. Losses from erosion increased; less and less money was spent by farmers for fertilizer, lime, and legume and grass seeds. Farm inventories for land and buildings declined alarmingly; the income from agriculture was cut in half; debt-ridden farmers were forced from their land in great numbers, and tenancy increased alarmingly.

During the defense period preceding World War II, and the war years of "all out" production, American farmers achieved the needed increased production of food and farm products for the manufacture of war materials. In spite of the call to the colors of over 2,000,000 farm men and women, older men and women and boys and girls and those incapacitated for armed service responded to war needs with a tremendous and unprecedented increase in production. Twenty per cent fewer workers on the land produced an increase of 30 per cent in farm production. The mistakes of World War I taught a great lesson, and less than 4,000,000 acres instead of 40,000,000 were shifted from grass and legume crops to soil-depleting crops. However, a tremendous draft was made on soil fertility.

A New Era of Soil Conservation, Balanced Agriculture, and Efficient Farm Practices. In the struggle out of the great depression after World War I, farmers cooperated in the national program which aimed to balance production with domestic and foreign demands and to bring efficient soil-conservation practices into general use. In spite of the two greatest droughts of the nation's history in 1934 and 1936, a sufficient food supply of all major commodities was provided for the American public. With the increase in purchasing power of agriculture, the industries that serve farmers, who remain



A serious loss of soil fertility due to uncontrolled washing has taken place on the plowed slope, and gullies that threaten the farm have developed. *R.A., U.S.D.A.*

This slope, held down by alfalfa, experiences practically no loss from soil erosion. *R.A., U.S.D.A.*

"The surface of the earth is practically within the care of the farmer."
—Dean L. H. Bailey.

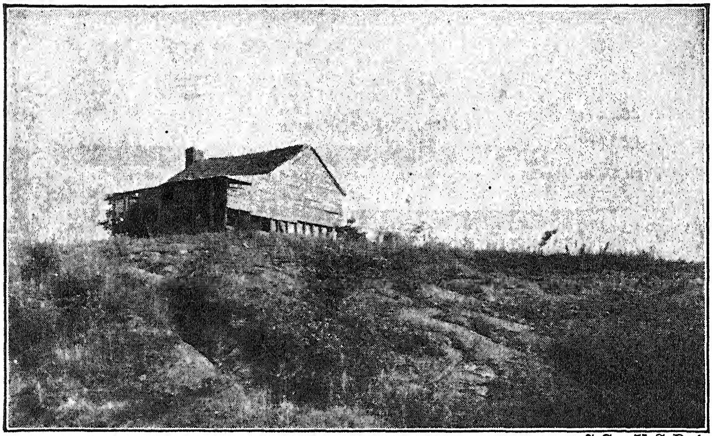
the nation's greatest buyers, felt the rejuvenating effects of the return of agricultural prosperity. The program, aimed at balancing production, placed emphasis upon efficiency of production as well as upon improvement in crop rotations to conserve fertility. Seed of improved crop vareities, the most efficient farm machinery, lime and commercial fertilizer, building material and fences, all were demanded in rapidly increasing volume by American farmers as prosperity returned.

During the decade before World War II, the use of lime was increased fivefold, and the use of phosphate and potash-carrying fertilizers was more than doubled. The acreage of grass and legumes was materially increased, and soil and water conservation came into general practice. Improved machinery placed farming on a more efficient basis. Hybrid corn and high-yielding crop varieties in general were planted. These achievements laid the foundation for the greatly increased crop yields that met our war needs and contributed greatly to the food needs of our allies during the war and of hungry people the world over when peace came.

The results of the scientific work of state and federal agricultural experiment stations and the federal agencies and extension service, culminating in the leadership of the War Production Board, which achieved national mobilization and cooperation of farmers, were major factors in the achievement of amazing production during the war years. The continuation of efficient farm practices with increased efforts in erosion control and fertility maintenance and improvement will place our agriculture on a much more permanent and profitable basis.

Our Obligation to Conserve the Land. The history of American agriculture during the 300 years or more of its development constitutes a remarkable record of transforming a vast territory of forest and prairies, savannas and swamps, well-watered bottomlands and arid deserts into a farming nation second to none in the efficient production of foodstuffs, fiber, leather, and agricultural raw materials needed for manu-

facture. In its virgin state, the land of our nation maintained a few million native Indians. These same lands, opened by American pioneers and developed by American farmers, now maintain our continental population of over one hundred and forty million people and contribute vast supplies of agri-



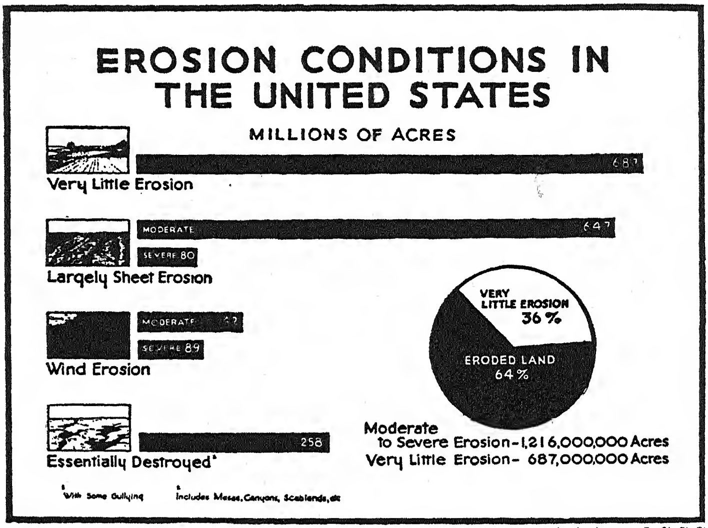
S.C., U.S.D.A.

There are many instances of misuse of our land and unchecked erosion which have led to soil impoverishment and abandonment.

cultural products for the world market in accordance with foreign demand.

The pioneer farmer wrested the land from the grip of primeval forests, broke the tough sods of prairies never before disturbed, underwent the hardships and braved the dangers of a new country. He grew the crops and livestock which his family needed in addition to the fish and game and wild nuts and fruits that he found in abundance about him. The pioneers were followed by several generations of farmers who made it their chief aim to get the largest yields possible from virgin or nearly virgin land, with little thought of the maintenance of fertility. The pioneers and those who followed them were masters in the production at low costs of grains and meat

and other products of the land. Until the late nineties, when the last large acreage of fertile public land was thrown open for settlement on the occasion of the famous homesteaders' rush to the Cimarron country of Oklahoma, it was the custom to abandon land that became infertile through cropping and



A.A.A. and S.C.S.

With the depletion of humus in our recently virgin soils, erosion has become recognized as a menace to our national welfare.

to move on to other new and virgin lands which were available. In the main, we should pay high tribute to our forefathers whose achievement in developing our agriculture was more responsible than any other factor for the building of our country and for the gaining of high rank among the nations of the world in a few short centuries.

Nevertheless, it is now generally realized that our agricultural progress up to nearly the present time constitutes a record of extractive farming aided by modern development in machinery and in transportation. It is doubtful if any people

ever before in the world's history took, in so short a time, as much fertility from the land which it was their privilege to own and enjoy, with as little consideration to the return of the elements of fertility and to the protection against the losses by erosion which followed the plow.

In July of 1936, the late Jacob G. Lippman, Director of the New Jersey Agricultural Experiment Station, one of the nation's outstanding authorities on our soils, issued his first published report on the inventory of plant nutrients in the soils of the United States (Bul. 607, New Jersey Experiment Station). This report includes the following conclusions:

> American agriculture started with vast soil fertility resources. These resources are still vast, but in the course of time there have been tremendous deductions from the original inventory of our plant nutrient resources. If we are to look ahead and to make provision for maintaining our soils at a satisfactory level of productivity, we not only must know about our soil resources but should also familiarize ourselves with the rate of soil depletion.
>
> . . . The history of agriculture in this and other parts of the world is full of examples of soil building as well as soil deterioration. . . . After all, the growing of crops is a mining process. The extent of soil mining must determine, in the long run, the ability of the nation to maintain itself in respect to the supply of food and of other agricultural products. If soil mining is not accompanied by effective soil management, the yields must inevitably decline. . . . Attention should be called, in the first place, to the net losses of calcium, potassium, and magnesium. The removal of these elements involves a gradual rise of soil acidity. With the loss of the basic substances of which these elements are a part, there is a more intense loss of phosphorus. Indeed, too much stress cannot be laid on the fact that our soils are suffering a net annual loss of about 3 million tons of phosphorus—or almost 10 times as much as is supplied by chemical fertilizers. It is well known that in some countries where the cumulative losses of basic materials have not been made up by liming, marling, etc., there have been a striking increase in soil acidity, a serious loss of phosphorus, and a marked shrinkage in the size of domestic animals.

The net annual loss of nitrogen, indicated at about 6.5 million tons, is really much greater in so far as our crop land is concerned. An assumed annual loss of 10 million tons of nitrogen in our agricultural land would be a reasonably conservative estimate. This would be equivalent to more than 30 times the amount of nitrogen supplied by chemical fertilizers.

The losses of the plant nutrients mentioned, as well as of sulfur, are of such a character as to call for the prompt adoption of measures which would offer to us assurance of more or less effective conservation and of a lessening drain on our resources of plant nutrients. Changed methods of soil management, which would include proper provision for lessening the losses due to erosion and leaching, would represent a major conservation measure. Such changes in our soil and crop management systems as would permit a lessening in the runoff, an increase in the amount of water stored in the soil, an increase in the area occupied by legumes, an increase in non-symbiotic nitrogen fixation, and a decrease in the excessive oxidation of organic matter would almost, if not quite, permit the elimination of the annual deficit in respect to our soil nitrogen resources.

These figures show conclusively the need for an agricultural conservation program that will check erosion losses, increase legumes and grasses that supply organic matter and nitrogen, and encourage the use of larger amounts of commercial fertilizers in connection with our crop and livestock production. To do this will require, of course, that farmers receive an adequate price for their products in order to include the cost of fertility maintenance and up-building as a necessary and essential part of the cost of production.

In the years that have elapsed since Dr. Lippman reported on the alarming losses to our fertility, marked progress has been made in the increased use of lime and fertilizers and in the employment of soil-conserving practices; but our fertility balance is not yet "out of the red."

Agriculture Offers a Varied Field of Opportunity. Farming today and in the near future offers unusual opportunity to those who love the land, the changing seasons, and living

things, both plants and animals, and who master proved practices in the production and marketing of crop and livestock products. A vast fund of knowledge has been developed by generations of farmers. This practical information has been passed on from generation to generation with the custodianship of the land itself. It is available through observation and contact with neighborly farmers who are to be found in all communities. In addition, during the past fifty years in particular, the scientists of the United States Department of Agriculture and of our land-grant agricultural colleges and experiment stations have contributed many improved practices in crop production which have been generally adopted by farmers.

Plant explorers have been sent to the four corners of the world to bring back grasses, grains, sugar plants, fruits, nuts, and other plants to enrich our agricultural possibilities. Examples of exceedingly valuable importations that have benefited many thousands of farm families and our nation as a whole are durum wheat, the sorghums, and sudan grass, drought-resisting crops which thrive in regions of moderate rainfall, such as the western part of the Great Plains region; the soybean, which has become one of the most important legumes of the Corn Belt, now widely used in livestock feeding and in providing industry with a valuable source of oil and protein for a variety of uses; and Korean lespedeza, another remarkable soil-improving legume used chiefly for hay and pasture, which has extended over millions of acres in the Cotton Belt and the southern half of the Corn Belt. Hardy varieties of alfalfa from the steppes of Russia, grasses from the Gobi Desert and Siberia, forage plants from Africa, disease-resistant sugar cane from the South Sea Islands have been collected by skilled and intrepid plant explorers for use where adapted in America.

Our forefathers received from the American Indians such remarkable gifts as the Indian corn, or maize, which vies with wheat as the most important cereal of the world; the

potato, which is produced more extensively by the world's peoples than any other crop used as a vegetable; the tomato, which is one of our most important sources of vitamins; tobacco; peanuts; the white pea-bean; and numerous varieties

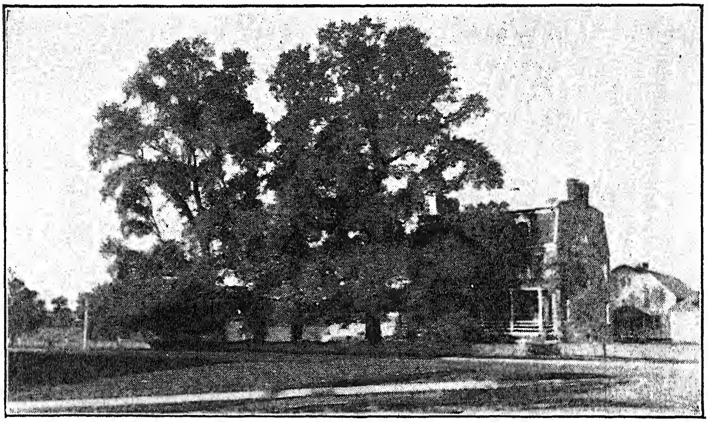


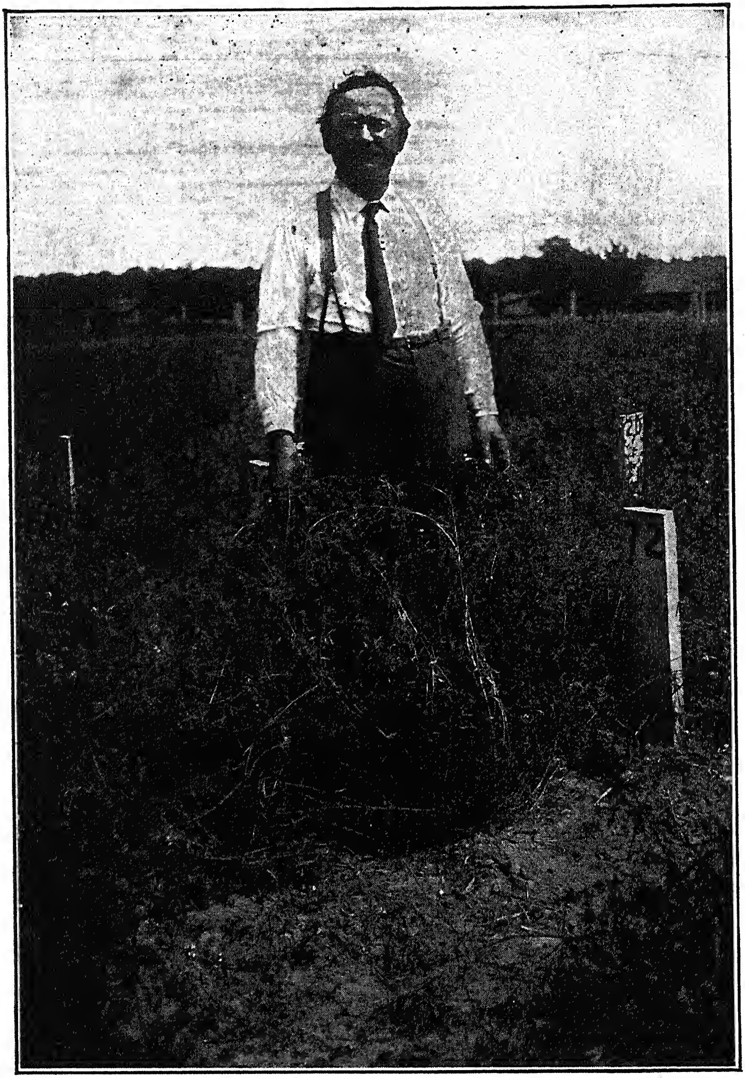
Photo by courtesy Director H. J. Patterson, Maryland Exp. Sta.

The "Rossbourg Inn." The first building to be used for agricultural experiments in America still stands on the campus of the University of Maryland. Experiments with potato culture were conducted in 1858 under charter by the general assembly of Maryland.

The Maryland Agricultural College, the second oldest in the United States, opened its doors to students a few months after the Michigan Agricultural College in 1857.

In 1862, Congress passed the Land-Grant Act and Agricultural Colleges and Experiment Stations followed rapidly in all States, contributing greatly to the advancement of American agriculture.

of squashes. No race on the face of the earth has contributed crops of greater value than these, developed through the centuries from wild native plants by the Indians of America. By careful selection, and of late years by scientific improvement at the hands of our experiment station plant breeders, crops and plants from the Old World and of Indian origin have been improved in yielding ability, quality, and disease resistance. More than any other factor the develop-



Modern Plant Breeders have contributed crop varieties of improved yield, disease resistance, and usefulness. From the alfalfa nursery shown above, the late Frank Azor Spragg of the Michigan Experiment Station, selected the Hardigan alfalfa.

ment of hybrid corn varieties has contributed to the increase in acre yields and expansion of the area of corn growing. In Iowa, for instance, the average yield of corn in 1915 was 30 bushels per acre with less than 5 per cent of the acreage planted to hybrid corn. In 1945 with more than 90 per cent of the Iowa corn acreage planted to hybrid corn, the unprecedented average yield of 61 bushels was secured. In many states, crop improvement associations have been formed for the purpose of increasing on a large scale new varieties developed by plant breeders of the experiment stations.

Botanists, plant pathologists, and agronomists have developed such practical methods of controlling crop diseases as efficient seed treatments for the stinking smut of wheat, the loose smut of oats, and the scab and black scurf of potatoes. They have also contributed to farm practice effective spraying methods, resistant strains, rotations, and cultural practices which control many plant diseases. Entomologists have made intimate studies of the life histories and habits of insects that cause crop losses and have devised methods of poisoning, trapping, or otherwise controlling damaging insects. The wartime development of DDT to control flies, mosquitoes, and lice contributed a new and most effective poison that has been found extremely useful in the control of insects that damage the potato, certain vegetables, fruits, and seed crops. The Hessian fly, once considered a menace to wheat growing, is controlled by planting wheat at proper dates. The European corn borer that very recently threatened our corn crop is controlled by effectively destroying corn stubble and stover and by dusting with 3 per cent DDT dust. Progress has been made in breeding corn varieties upon which the corn borers do not thrive.

Bacteriologists have explained the function of the bacteria living in the root nodules of leguminous plants in contributing nitrogen from the air to the plants and to the soil. In little more than two generations, they have made farmers aware that the soil is not a lifeless, inert material but that working

beneath the surface of the soil is a vast world of active, living organisms made up largely of bacteria, fungi, worms, and nematodes. The bacteriologists have taught us that without the proper functioning of these living organisms within the soil the growth of plants and livestock on the surface of the soil, in fact man's life and progress, would be impossible.

Chemists working in their laboratories and with experimental plats have contributed new and effective methods of soil fertilization and soil management. Great progress has been made in ascertaining the requirements of plants and of soils for phosphorus, nitrogen, potassium, calcium, and rarer elements needed in plant growth. The chemist has also enlarged the market for farm products by developing new uses in industry for the oils, proteins, and starches of such crops as corn and soybeans. He has extended, also, the uses for cellulose, increasing the marketing opportunity of the cotton grower. During World War II three-fourths of our synthetic rubber tires were made from grain alcohol produced from corn, wheat, rye, and grain sorghum. Grain alcohol was employed in the manufacture of high explosives and high-octane gas and of plastics used in our great bombers and combat and transport planes. It is estimated that one acre of corn land produces a greater weight of synthetic rubber than the natural rubber one and one-half acres of Sumatra rubber plantings could produce. One bushel of corn produces two and one-half gallons of grain alcohol, about the amount needed to produce the synthetic rubber for one average automobile tire. Experts consider that the field of opportunity for the chemist in applying his technical knowledge to agriculture is yet in its infancy in spite of the remarkable progress which has been made.

Agronomists have improved the methods of plowing and preparing the land, and of planting, cultivating, harvesting, and storing crops. They have increased our knowledge of crop uses and adaptation and of the growing of crops in

efficient rotations to conserve the soil from erosion, increase organic matter, and effectively distribute farm labor throughout the season.

Inventors have contributed improved plows with chilled-steel moldboards, the disk and spring-toothed harrows, culti-packers, improved cultivators, mowers, reapers, binders, com-

Pennsylvania State College, Agricultural Extension Service

Improved farm machinery has speeded up the work and lessened labor costs of plowing and fitting the soil, fertilizing, and planting.

bines, corn- and potato-harvesting machinery, improved threshers, silage cutters, and numerous machines for special crops and purposes. The development for agricultural use of the gas engine and the increasingly widespread use of tractors, trucks, and automobiles during comparatively recent years have added tremendously to the producing power of the man engaged in farming. During World War II corn, our leading "war crop," was placed largely on a mechanical basis from planting to harvest and from delivery to market. Mechanical corn pickers came into general use. Mechanical cotton pickers were developed and will probably revolutionize the cotton industry. Flame throwers and other machines using

fire are now being used on an effective basis in controlling weeds.

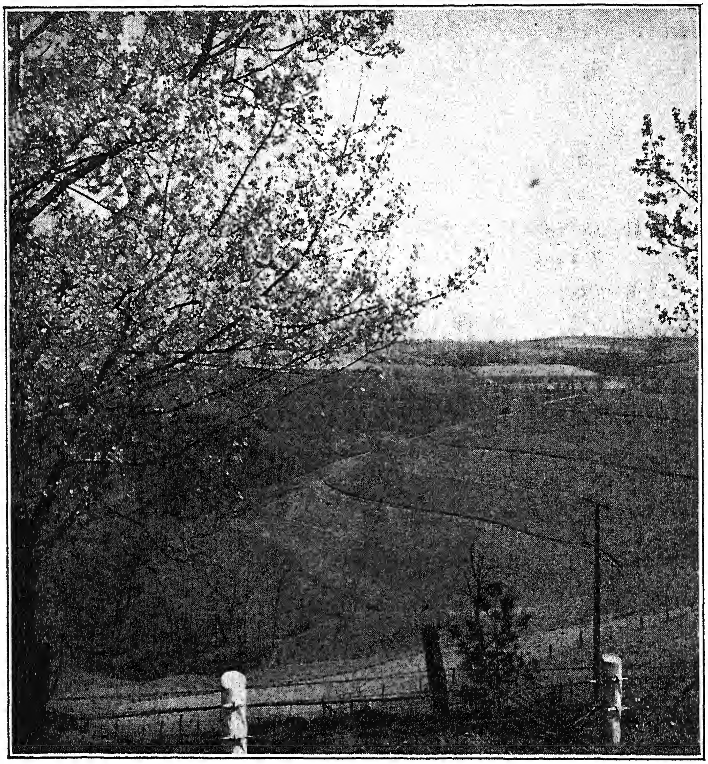
The Atomic Energy Commission is now supplying isotopes of carbon, phosphorus, iodine, sulphur, and other elements which are being used by scientists in tracing the passage of elements and their ultimate deposit in plants and animals. New vistas have been opened in plant and animal nutrition and fertilizer investigations. The key to the functioning of chlorophyl may be found through the use of isotopes and modified Geiger detectors to trace their passage through living plant tissues.

Much progress is still to be made in the adaptation of machinery to the smaller farms. Small rubber-tired tractors with accompanying land-fitting, cultivating, and harvest equipment are rapidly increasing in use on small farms. We are now on the threshold of a new age of power application, with electricity bringing light and power for a multiplicity of uses in farm homes and barns throughout the nation.

Abraham Lincoln, in words that have not been improved upon, described the opportunity that agriculture offers to the trained and inquiring mind:

> No other human occupation opens so wide a field for the profitable and agreeable combination of labor with cultivated thought as agriculture. I know nothing so pleasant to the mind as the discovery of anything that is at once new and valuable—nothing that so lightens and sweetens toil as the hopeful pursuit of such discovery. And how vast and how varied a field is agriculture for such discovery! Every blade of grass is a study . . . The rudiments of science are available and highly available. Some knowledge of botany assists in dealing with the vegetable world—with all growing crops. Chemistry assists in the analysis of soils, selection and application of manures and in numerous other ways. The mechanical branches of natural philosophy are ready to help in almost everything, but especially in reference to implements and machinery. The thought recurs that education—cultivated thought—can best be combined with agricultural labor or any labor on the principles of thorough work. . . . No community whose every member pos-

sesses this art can ever be the victim of oppression in any of its forms. Such community will be, alike independent of crowned kings, money kings, and land kings. (Address before Wisconsin Agricultural Society, Milwaukee, 1859.)



U.S.D.A. Soil Conservation Service

Strip cropping with cultivated crops alternating with grass or small grain crops prevents erosion.

Farmers Cooperate in Soil Conservation, Production, and Marketing. The experience of American farmers in meeting the demands of the two greatest wars of our history, in coping with our greatest droughts and the depression period, and in

contributing to the post-war world needs of starving peoples, has convinced the vast majority of the necessity of continued cooperative effort.

The farmer cooperatives, sponsored by the Farm Bureau, the Farmer's Union, and the National Grange, have made tremendous strides in furnishing to farmers supplies needed in production such as fertilizers, feeds, seeds, and farm equipment and in marketing livestock, grains, fruits, eggs and poultry, and other farm products.

The Soil Conservation Service offers increased opportunity to farmers who cooperate in local soil conservation programs under State District Conservation Acts. The Farm Credit Administration offers loans for farm purchase and crop and livestock production under the direction of local farmer-elected boards.

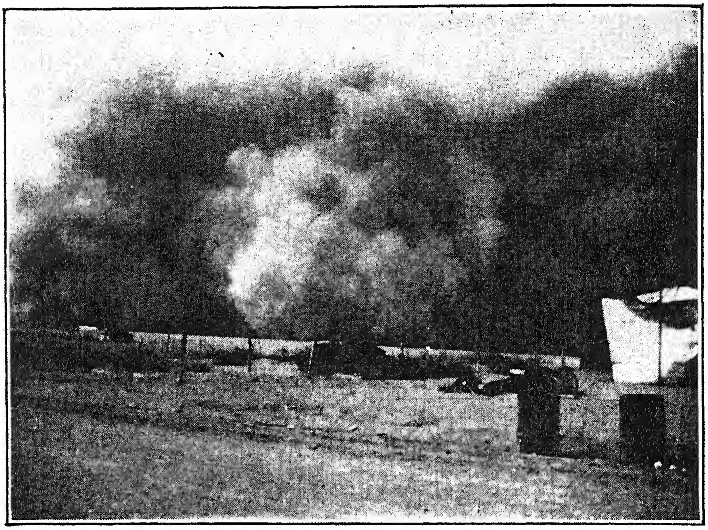
The Production and Marketing Administration, formerly the Agricultural Adjustment Administration, gives materials and direct aid to farmers in soil-conservation practices, in balancing production, and in meeting situations caused by war, drought, flood, or other emergencies. Crop insurance has been made available on wheat. These programs, however, are in a transitory and experimental stage.

The Rural Electrification Administration has been extremely effective in bringing electricity to thousands of farms on a cooperative basis.

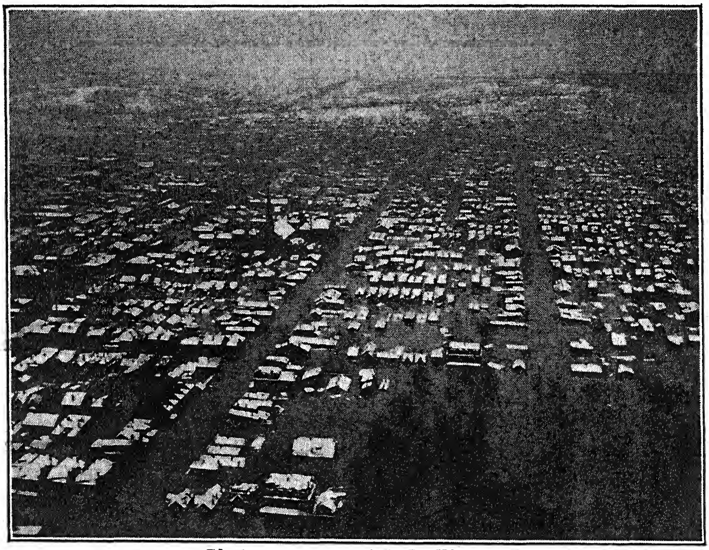
The agencies forwarded by the agricultural extension service of the states include such valuable organizations as seed and livestock improvement associations, soil improvement associations, and 4H Club work.

The vocational agricultural high schools have rendered splendid service in their localities through the Future Farmers of America.

It is highly important that present-day farm operators familiarize themselves with the opportunities of service offered by all agencies that serve agriculture, and that they participate in those agencies that can render specific benefit.



Dust storms occur when soils in dry regions are plowed. A heavy pall of dust advancing over a farm in the Northwest during the drought of 1934.



Photos courtesy of J. B. Kincer, U. S. Weather Bureau

Heavy rainfall and unprotected watersheds cause floods like this of the Ohio at Cincinnati in 1937. Water at 80-foot level, 10 feet above previous records.

U.S.D.A. Soil Conservation Service

The farm woodlot provides timber, firewood, nuts, protection and food for birds and other wild life and protects and rebuilds the soil.

Through federal and state cooperation, and collectively through a super-development of farmer cooperatives, it is apparent that American farmers must work together in efficient production and marketing, in balancing their production in accordance with market demands in order to achieve prices above production costs, in stabilizing and protecting the business of farming, and in conserving the very land itself.

SUGGESTIONS

1. Should "future farmers" spend time in studying crop management and soil conservation?

Deal with this question from the standpoint of home farms and local communities first and then think of it in terms of state and nation.

2. Whose responsibility is it to see that farm lands are kept in good condition?

3. Can individual farmers carry the burden of conserving the soil resources of the farms of the nation?

4. What is the relationship between the farmer's ability to conserve the soil of his farm and the prices he receives for farm products?

5. What is the relationship between the welfare of farmers and the welfare of persons living in cities?

6. What have been some of the agencies contributing to the improvement of agriculture?

7. How will it be possible for farmers to balance production with market demands?

8. After World War II, what measures were taken, by farmers, to increase food production and, by the public, to conserve and share food to relieve world-wide starvation?

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CHAPTER II

SURVEYING CROP PRODUCTION FROM THE FARM MANAGEMENT STANDPOINT

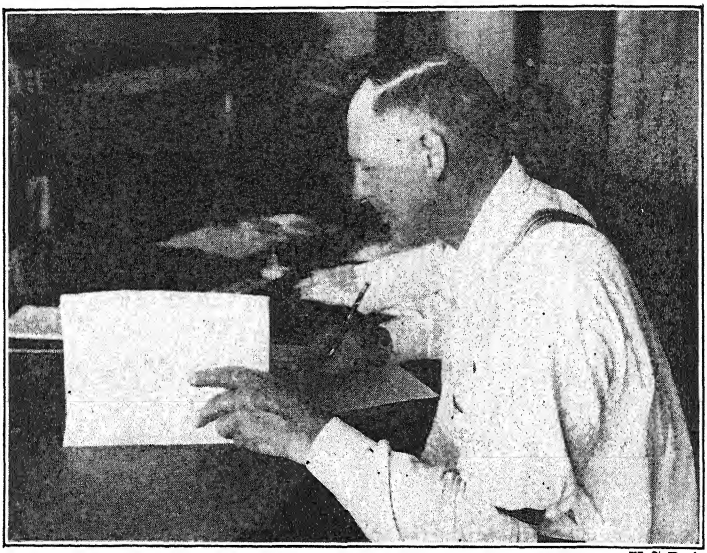
"Long ages of experience and a generation of scientific research have resulted in a fund of popular knowledge on how to raise crops and animals." G. F. Warren

A successful farmer has the ability to bring together many different enterprises or phases of farming into one well-organized unit for the purpose of making an income sufficient to establish a home and to carry on the farm business. The handling of the soil, the growing of crops, the production of livestock, the marketing of products, the financing of the business, together with many other factors, must be balanced in a system of efficient farm management if success is to be achieved.

It is recommended that the students using this book, with their teacher, make a study or an analysis of the place of crop production and soil conservation in a given farming program. Begin by following the principle of thinking about a farm and its management as a whole and then, by breaking the whole into its various divisions, determine the relative importance of the parts. It is very important to understand the relationship between crop production and soil conservation and the other parts of a farming program which must be managed as a unit or whole.

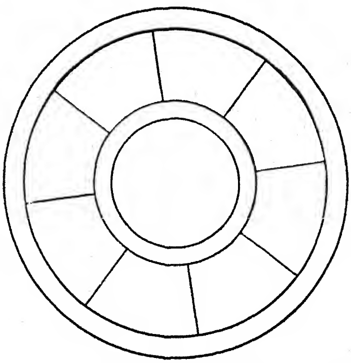
The following procedure is suggested as an aid in determining the parts which together make up a farm business.

Farm Management Relationships. Place upon a blackboard or piece of paper a copy of the diagram shown below, making the diagram as large as the space will permit.



U.S.D.A.

A study should be made of the place of crop production and soil conservation in a given farming program.



What is it that keeps the spokes in the wheel of farming balanced in the right working relationship? Place in the wheel diagram the words that describe the part played by the farmer as manager.

The circle as a whole represents a total farm business. Label the parts of the diagram according to the suggestions which follow.

1. What is the purpose of being a farmer?

   Many answers may be thought of, but from a discussion of this question it may be expected that thoughts will center around the idea of living a satisfactory life in an excellent rural home. Decide upon a word or short phrase which expresses the idea and place it in the center of the diagram. It is well to give thought not alone to crops, cows, and chickens, but to the chief purpose of engaging in the occupation of farming.

2. What is needed to insure the establishment of a modern farm home?

   The short answer is "money," or, in other words, a reasonable financial return from the farm business. Label the space just outside the center circle with terms referring to farm income.

   In the discussion relating to farm income, it would be well to recognize that income alone does not insure a satisfactory home. Money must be wisely expended as well as earned.

3. How can a satisfactory farm income be obtained?

   With reference to the diagram, a satisfactory farm income can be insured by putting the proper spokes in the wheel of farming. A search in textbooks on farm management or in farm account books will reveal that the spokes referred to are often called "factors which affect labor income."

   Insert as many spokes in the wheel as necessary and label them. Some suggestions follow.

   a. Efficient crop production.

   The handling of the soil in crop production and the solving of the problems in connection with the crops themselves are real tests of the ability of a farmer. The soil needs to be used wisely and to be conserved in the interests of a stable agriculture.

   b. Efficient livestock production.

   A long outline could be prepared of items to be considered in connection with efficiency in livestock production.

   c. Labor efficiency.

The correct use of labor and power is very essential if a farm is to be well managed. It will be observed that the arrangement of farm buildings and the field arrangement have a very definite connection with labor efficiency. The amount and kind of machinery, horse power, and man power must all be considered.

d. The right kind or type of farming.

The kind of farming practiced must be adjusted to climate, land, available labor, markets, and other factors.

e. Proper size and volume of business.

The farming business should be large enough to insure a reasonable income. In farming, large profits cannot be expected from a small business. An oversized farm business may be difficult to manage in a profitable manner.

f. Good balance and diversity of farm business.

In farming it is good business to have several sources of income, such as various cash crops or several different livestock products. When more than one enterprise is being carried on, it is very important that the right balance be maintained. Money can be made on one enterprise while another enterprise is conducted at a loss. The right number and type of livestock should be kept to fit in with a certain cropping program. Poor balance causes an inefficient use of land, labor, and capital.

g. Adequate financing.

Money is needed to run a farm business and should be available through a sound program of financing.

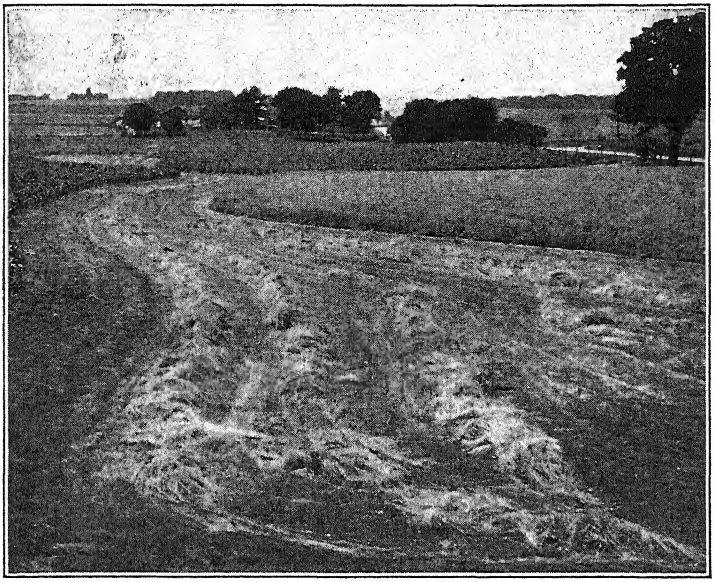
h. Efficient marketing.

One of the most important phases of modern farming has to do with the marketing of products.

The items *a* to *h* are some of the spokes in the wheel of successful farming. Students and teachers may easily think of other items to be added.

4. What is it that keeps the spokes in the wheel of farming balanced in the right working relationship, as the rim of a wheel helps to hold all the spokes within a wheel the proper distance apart or in the right relationship? What is the force which balances the factors affecting labor income?

The answer, of course, is the farmer. The farmer's intelligence expressed in terms of farm management is what makes for successful farming. It must be remembered too that successful farm management depends also upon the farmer's wife



U.S.D.A. Soil Conservation Service

The security of the farm home depends upon the efficient production and marketing of crops and livestock and the maintenance and improvement of fertility.

and his children, for farming is usually a cooperative family enterprise.

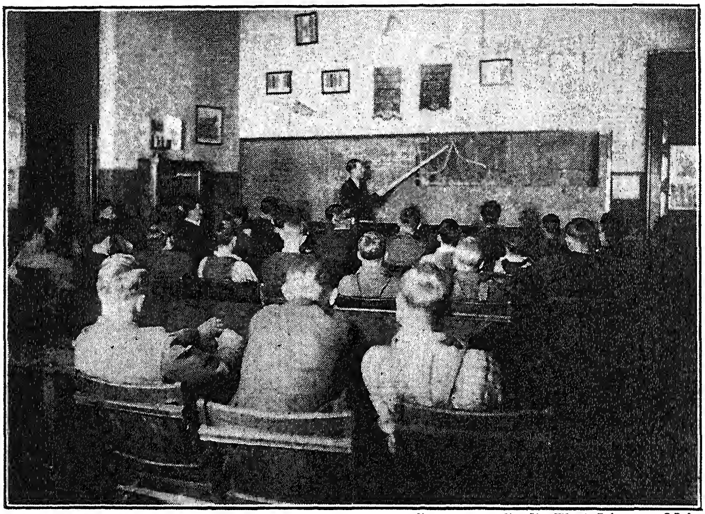
Place in the rim of the wheel diagram words or phrases which describe the important part played by the farmer as farm manager.

5. One more step.

The diagram may appear to be complete but there are additional important items to consider.

In modern times there are many things which affect the farm business and the farm home. These may all be classified as eco-

nomic and social factors affecting farming. Such a phrase as this might be written around the outside of the wheel diagram to show that the farmer, his business, and his home are surrounded by such influences. The present-day farmer must expect to be influenced by many factors over which he, as an



Courtesy C. S. Hutchison, Ohio

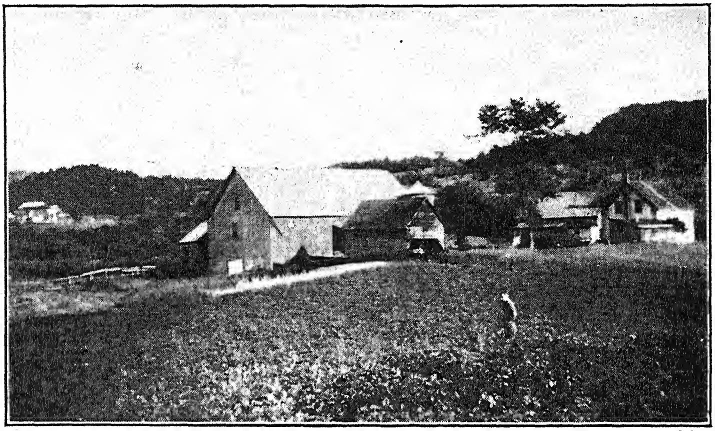
Students and teacher study the economic and social factors influencing farming.

individual, has very little control. A farmer and his family cannot live entirely by themselves; they become a part of a great social system, with a part to play in molding the social organizations with which they come in contact.

A brief list of some of the economic and social factors affecting farming may be listed as follows:

a. Industry and business in relation to farming.
b. State and federal legislation.
c. World conditions as they affect markets for farmers' products.
d. Taxation for support of government.
e. Other such factors.

Survey of Farms. The practical problem facing students of agriculture in connection with crop production is making improvements in a farming plan already in operation. Upon home farms certain crops are being raised and certain soil-handling practices are being followed. What are the improvements which need to be made in the interests of better farm management?



Courtesy E. H. Little, New Hampshire

The certified seed-potato project of a New Hampshire student of vocational agriculture. Vocational agriculture projects carrying through the growing season are essential to effective instruction.

If a beginning is made from this point of view it is essential to make an investigation of the crops being raised and the practices being followed. Out of this search should develop a plan for solving the problems connected with improvements in the farming program.

Survey of Crop Production. It is suggested that students and teachers make a survey of the crops being raised and the crop-production and soil-handling practices being followed on the home farms of students. Often it is desirable for students and teacher to select a farm which is rather typical for the

community and make an intensive survey of this farm. Such a plan makes it possible for each student to become familiar with the farm and the problems it presents in crop production and soil conservation. A great advantage is obtained in class discussion if all students are familiar with the same situations. A good plan to follow is to use a typical farm for intensive study and then make applications of the facts and plans developed to the home farms. The following items are suggested for the survey.

1. What crops are being raised?

   List names of crops, varieties, acreages, and yields for a given year. A map of the home farm, or of the farm being studied, may be made to show the acreage in each field and the use to which the land is devoted. Large sheets of graph paper are very convenient to use in making maps of farms.
2. For what purposes are the crops grown?

   Classify the various crops according to their use about as follows:

   a. Cash crops.
   b. Crops for feeding livestock.
   c. Crops for home family consumption.
   d. Crops grown to maintain and improve the fertility of the soil.

3. What crop rotations are being followed?

   Make a list of the rotations being followed. Make note of crops not grown in rotation and of land which is devoted to the continuous production of a given crop.
4. What typical kinds of soil are found on the farms?

   Samples of soil should be taken from various parts of the farm or farms being studied. Such samples will be needed in learning about types of soils and the needs of the soil for lime and fertilizers. It is suggested that certain samples be forwarded to state soils laboratories for analysis so that the information may be available for use in planning cropping and fertilizing programs.
5. What problems or difficulties are encountered in crop production and soil conservation?

While information is being gathered by means of the farm surveys it is particularly important to gather facts about particular problems or troubles which are causing difficulty. The following points are suggested for investigation:

a. What particular evidence is there of poor soil conditions or low fertility?

Poor growth of crops, spots where crops have failed, evidences of poor drainage, failure of legumes, and so on, are items which should be noted.

b. What indications of soil erosion are present?

Look for evidences of sheet erosion. Estimate the size of areas affected by gullies.

c. What weeds are causing difficulty?

Gather samples of the troublesome weeds, both plants and seeds if possible. Dig up specimens of Canada thistle, quack grass, and other weeds which are particularly troublesome, in order to have the root system on hand for study. Secure samples of threshed grain to be inspected for the presence of weed seeds. Such material as the above may be stored and used for class purposes when the time comes for an intensive study of weed control.

d. Are crops being destroyed by insects?

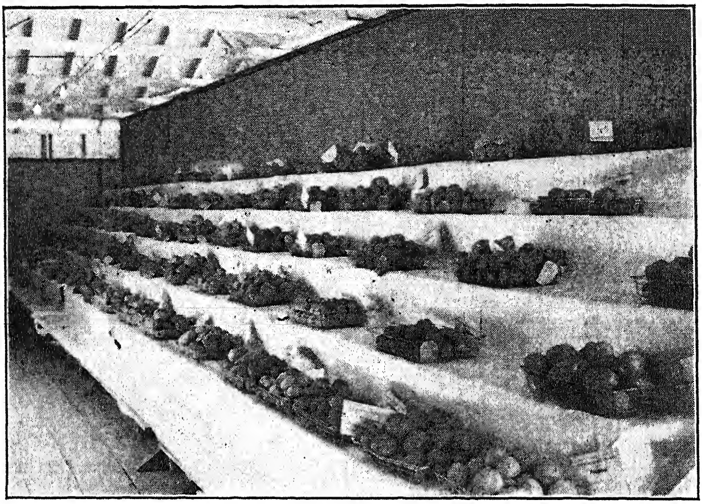
Gather any evidence pertaining to losses caused by insects. If possible secure specimens of the insects causing the damage.

e. Are diseases reducing the yield of crops?

Gather from the crop fields and from the harvested crops all the specimens of diseased plants which can be discovered. These specimens may be stored until the time comes to give particular attention to the control of crop diseases. Cornfields will supply many specimens of diseases affecting the corn crop. It is interesting to count in a cornfield the number of diseased stalks, barren stalks, and missing plants that are to be found in a hundred hills. Results can be compared to what a perfect stand, at the rate planted by the farmer, might possibly have yielded. All the loss cannot be laid to disease, but some estimate can be made of the loss by disease.

Where row crops, such as drilled corn or potatoes, can be inspected, some estimate of the importance of disease can be made by finding the number of diseased plants in a hundred.

Use of Farm Survey Information. The information gathered by means of the farm surveys should serve as a basis



The Ohio Future Farmers of America who prepared this state fair exhibit vastly increased their knowledge of potatoes.

for discussion throughout the course of instruction in crop production and soil conservation. The actual farm situations which the survey provides will be useful as the principles of profitable crop production are developed. Actual knowledge of farm conditions must be available for the planning of improvements in the farming program and for purposes of planning the details of supervised practice programs.

Throughout the book, references will be made to the use of farm information obtained in the surveys.

It is recommended that students and teachers summarize the information gathered in the surveys in a form convenient for reference work.

SUGGESTIONS

1. Have each student prepare a diagram of farm management relationships which embraces as many original ideas as possible. After this work has been completed, place a large diagram on the blackboard and fill it in with the best suggestions growing out of the work of students.

2. Place before the students the problem of securing the information needed about crops being produced and the crop production practices being followed. Guide students in preparing survey forms. The plan of formulating student committees to investigate different phases of the problem might be tried. After the surveys have been made spend a short time in summarizing the information or assembling it in useful form.

3. Whenever a new phase of crop management and soil conservation is to be considered begin by analyzing its importance in relation to efficient farm management and by discovering the farm problems involved as revealed by the farm surveys.

4. Throughout the program of instruction keep the various farm management relationships in mind. It might be well to prepare a diagram of farm management relationships in chart form in order to have it ready for use on many occasions.

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CHAPTER III

THE NATURE AND USE OF CROP PLANTS

The development of Civilization has been hand in hand with the development of Agriculture.

From the dawn of history the human race has been engaged in selecting the plants of the earth best suited for man's use for food, pasture, and feed for his livestock, for clothing and building materials to protect him against the elements, and plants suited for medicinal use and as stimulants. In the beginning native plants were harvested as they grew for food, clothing, and other purposes. A great advancement in civilization came with the selection and storing of seed of the most useful plants, and with the planting, cultivating, and protecting of the crop against the depredation of animals and other tribes. Then it was, with the supply of food and clothing assured, that civilization as we know it really developed. The planting, cultivating, and harvesting of plants required fixed habitations and made possible the growth of communities, towns, and cities. The growing of plants and the tending of livestock were delegated to a part of the population, leaving others free for the development of government, the professions, law, art, medicine, music, literature, trade, commerce, and the military profession.

The development of civilization has gone hand in hand with agriculture. In our present highly complex civilization, further advancement is being made in improving plants for food and feed purposes, in lengthening the staple of cotton, strengthening the fiber of flax, increasing the oil content of soybeans and the protein and oil of corn, increasing the oil content of peppermint, the nicotine in tobacco for insecticide use, the

protein content of wheat, and the sugar content of beets through the employment of the lately developed science of plant breeding. The increased use of such products as the oil and meal of the soybeans for manufacturing the many parts used in automobiles, the use of straw and corn stover

Pennsylvania State College

A high-yielding Pennsylvania wheat crop. Wheat has long been the leading cereal consumed by human beings.

for paper and box board, alcohol for synthetic rubber, plastics, high-octane gas, and explosives, corn oil for food, the cellulose of cotton for explosives, rayon, cellophane, and many other multiplying and increasingly important uses of crop products in manufacturing have increased the outlets for agricultural products.

The farmer and consumer are particularly interested in the classification of plants and their products from the standpoint of use. The plant breeder and the seed producer must know the botanical classification of crops. Very recently the classification of crops as soil-depleting or as soil-conserving has

become of primary importance to the farmer who desires to improve his rotations and to the soil conservationists interested in the planning of community, state, and national land conservation programs.

This chapter presents:

1. Classification of crops according to use.
2. Botanical classification of crops.
3. Soil-depleting and soil-conserving crops.

Classification of Crops According to Use. *The pasture crops* include any herbaceous plants on which animals pasture or graze. The grasses, such as bluegrass, redtop, orchard grass, and the legumes, represented by the clovers, alfalfa, sweet clover, and lespedeza, are our leading pasture plants. *A pasture* is a field containing herbaceous plants upon which animals graze. *Permanent pastures* are fields, planted to pasture grasses and legumes or allowed to come up in native growth of these plants, which are used for several years or more for pasture purposes.

Hay crops are grown primarily for the production of the dried stems and leaves for hay, although most of them are important pasture crops. Timothy, redtop, and orchard grass are the most important hay grasses. Alfalfa, clover, sweet clover, and lespedeza are the most important legumes harvested for hay.

The cereals are crops, chiefly grasses, grown primarily for the use of the seed. Wheat, oats, barley, rye, corn, and grain sorghums are leading cereals of the grass family. For practical purposes, grain flax, buckwheat, and seed-producing millets are included as cereals.

Fiber plants are grown primarily for fiber purposes. Cotton, flax, and hemp are leading representatives of the fiber plants.

The term *root crops* is applied to plants whose principal value is in the underground part, whether true roots or tubers. Of the true roots the sugar beet, turnip, rutabaga, and stock beets, such as the mangel-wurzel, are most important. Of the

tubers included for practical purposes as root crops the potato and sweet potato are of greatest importance in our agriculture.

Medicinal plants and stimulants include: peppermint and spearmint, ginseng, wormwood, and belladonna, grown for medicinal use; and tobacco, tea, coffee, and the cocoa plant, produced for use as stimulants.

The leading *sugar plants* selected and developed for their sugar are the sugar cane, sugar beet, and sorghum which is grown for sorghum molasses and for forage.

The following definitions are important from the standpoint of the use of crops:

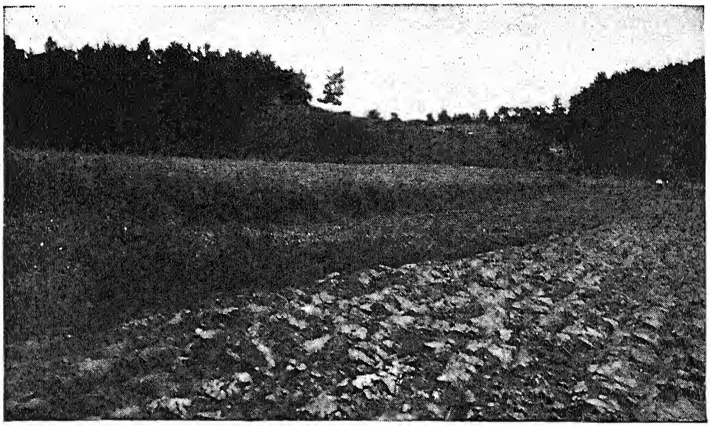
1. *Grass,* used in a general sense, is a term applied to any plant, either a true grass or legume grown for hay or pasture.

2. *Forage crops* include those plants grown to supply pasture, and hay or roughage feed for livestock. Pasture and hay crops, cereals grown for hay, pasture, or silage, and root crops used for feeding livestock are all included under the term forage crops when used for livestock-feeding purposes.

3. *Fodder* in a general sense means "feed," but in the United States it is applied to corn cut before the corn plant is fully matured and with the ears remaining on the stalk. The term *stover* is applied to the cornstalk and leaves after the ear is husked.

4. *Hay* is the dried leaves and stems of fine-stemmed grasses or of legumes. Hay is generally cured in the sun but of late years the artificial drying of hay has become important, particularly in the complete drying of alfalfa which is to be ground into meal. In addition to the well-known hay crops, such as timothy, redtop, prairie, and marsh hay of the grasses and alfalfa and clover of the legumes, the making of hay from soybeans, cowpeas, and field peas and from oats, barley, rye, and wheat cut before maturity is of increasing importance. *Brown hay* results when grasses or legumes are stacked in a compact mass, which encourages fermentation, and are heated. In regions where climatic conditions do not permit drying, brown hay is frequently made.

5. *Green-manuring crops* are crops which are grown for the purpose of increasing the organic-matter content of the soil by plowing under or by incorporating in the soil by use of the disk. Rye and vetch, crimson clover, peas and oats, soybeans and cowpeas are representative of our most important green-manuring crops.



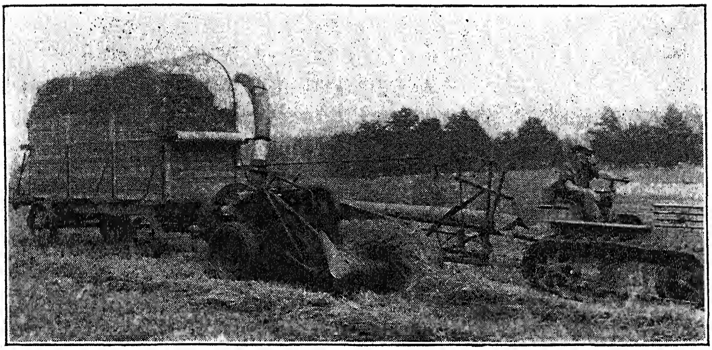
Turning under a green-manuring crop of sweet clover on sandy loam in preparation for potatoes the following year.

6. *Soiling* is a term applied to the practice of cutting plants while green and carrying the green forage to animals. During periods of drought when pastures dry up, corn, soybeans, sorghum, and other crops are frequently cut and carried to the feed lots.

7. *Silage* is the term applied to herbage which has been packed in a silo or trench in which the material undergoes fermentation. Corn and sorghum are the principal crops used in making silage in America. The corn or sorghum is usually cut with a silage cutter into small pieces about one inch in length and packed in the silo or in a pit or trench dug in the ground. Grasses, legumes, and sunflowers are also used in making silage.

8. *Straw* is a term used to describe the stems and leaves of a crop from which the seed has been threshed. Our leading straw-producing crops are wheat, oats, rye, and barley, but the term straw is also applied to the threshed roughage from alfalfa, clover, soybeans, millet, and flax.

9. *Roughage* is a term applied to hay, fodder, stover, pasture, silage, and roots used for animal-feeding purposes.



Pennsylvania State College, Agricultural Extension Service

A modern type of forage crop harvester that cuts the forage into fine pieces and loads wagon for delivery to silo.

10. *Aftermath or rowen* is applied to second growth resulting after a hay crop of grasses or legumes has been harvested.

11. *Nurse crops* are companion crops of small grains or other crop plants, with which accompanying seedings are made of legumes and grasses for hay, pasture, and seed-crop purposes. The nurse crops are usually harvested as grain or hay, or they may be pastured or clipped and allowed to lie on the ground.

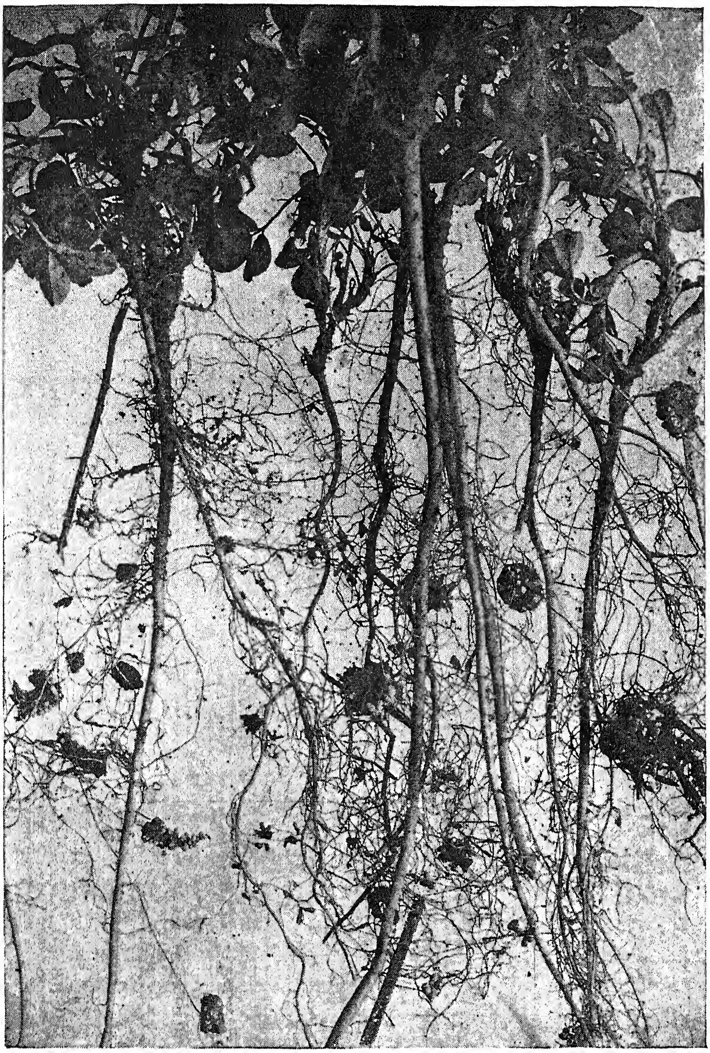
12. *Soil-conserving crops* are crops that prevent erosion by wind and water and that contribute organic matter or humus to the soil. They provide root and top growth that bind the soil. They are generally drilled or seeded broadcast and not intertilled with cultivators; they are used in such a

way as to make substantial contributions of crop residues, they are turned under for green-manuring purposes, or they are left on the land. Under the agricultural conservation program, the soil-conserving crops include annual legumes, such as vetch, winter peas, lespedeza, burr and crimson clover; biennial legumes, such as red clover, alsike, mammoth clover, and sweet clover; and perennial legumes, such as alfalfa, kudzu, lespedeza, sericea, ladino, and white clover. Such perennial grasses as bluegrass, timothy, redtop, orchard grass, buffalo grass, brome grass, or grass mixtures, small grains—when seeded as a nurse crop, pastured (or not pastured), and clipped green, or when grown alone (pastured or not pastured), and turned under as a green-manure crop—and annual legumes, such as soybeans, cowpeas, winter peas, and crimson clover, when grown as a green-manuring crop to be turned under or left on the land, are classified as soil-conserving crops.

13. *Soil-depleting crops* are the cultivated crops, grain crops, and special cash and truck crops which make heavy drafts on the fertility of the soil and which, through soil depletion and lack of coverage, encourage losses through erosion.

14. *Drought-resistant crops* are crops that maintain production at comparatively high levels under conditions of drought or withstand drought and grow again when rain comes. Such crops as the sorghums, sudan grass, millet, and established sods of buffalo grass, crested wheat grass, slender wheat grass, brome grass, alfalfa, and sweet clover represent the drought-resistant crops. Soybeans are also considered fairly resistant to drought because they can withstand more drought than corn and they have the ability to resume growth after a longer period of drought than corn.

Botanical Classification of Crops. The grasses of the family *Gramineae* and the legumes of the family *Leguminosae* are the most important botanical groups developed by man for his use. Upon the grasses depended originally the herds of



The legumes are of primary importance in soil conservation in that they increase the supply of nitrogen in the soil from the air through the agency of bacteria that develop in the nodules of the roots when properly inoculated. The above shows nodules on sweet clover roots.

grazing animals, upon which man in turn depended for his meat and milk supply. Certain forms of grasses producing large seeds which could be ground into meal for bread purposes have become our leading cereals. The grasses produce ribbon-like leaves with the growing point near the base of the

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Soil-depleting crops include cultivated row crops, small grains, and cash and truck crops which make heavy drafts on the fertiilty of the soil and give little cover to prevent erosion.

leaf; this permits the upper part of the leaf to be bitten off in grazing without injury to the growing points. The leaves of grasses are quickly renewed after being grazed; hence the grasses are most important as the foundation plants for our pastures. In addition to reproducing themselves by seed production, many of the grasses reproduce vegetatively by sending out *stolons* or underground roots or *rhizomes*. The grasses, as a class, are highly palatable to livestock.

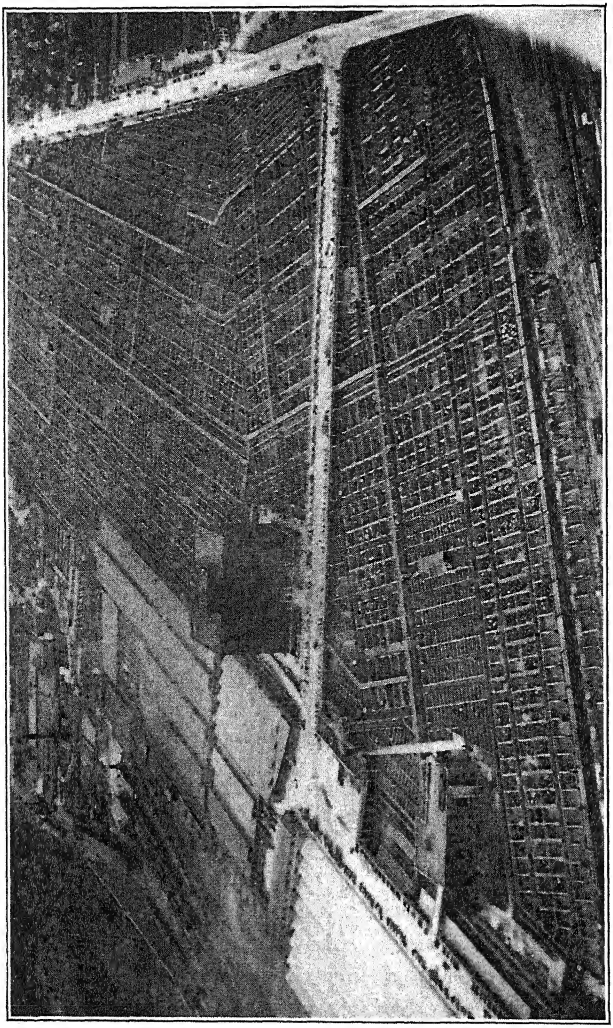
The *legumes* are of primary importance because they furnish pasture and hay high in protein and mineral salts and because

the family *Leguminosae* has the peculiar property of increasing the supply of nitrogen in the soil from the air, owing to the agency of *symbiotic* or partnership bacteria that develop in the nodules on the roots of legumes which are inoculated.

U.S.D.A. Extension Service

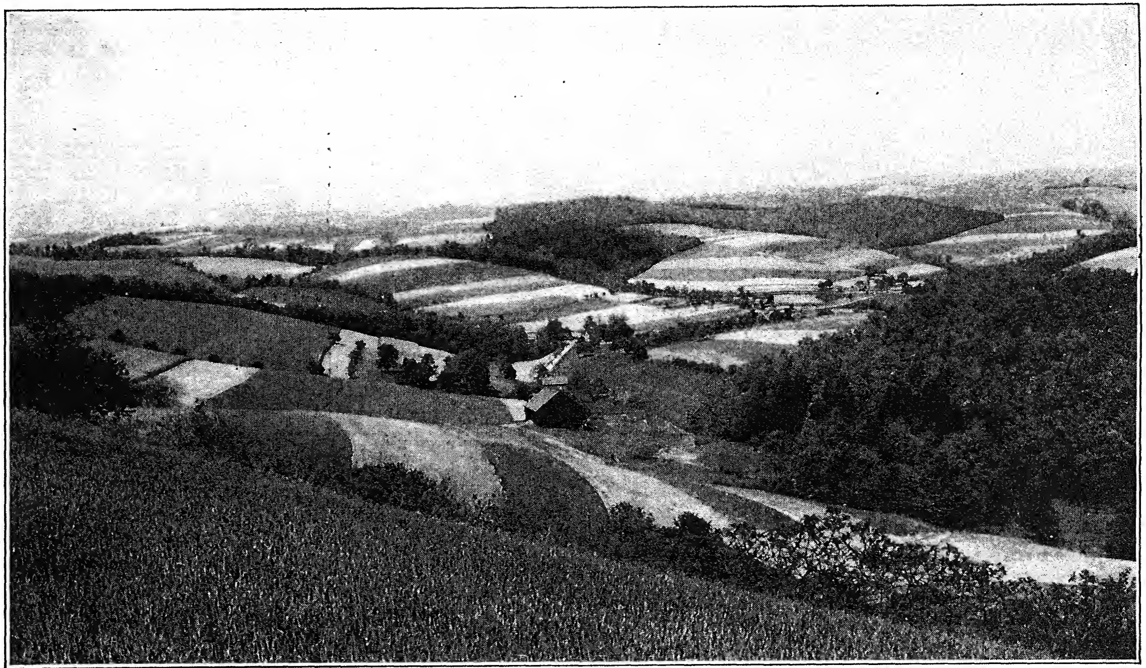
Ladino clover in Massachusetts. Soil-conserving crops include the grasses and legumes that provide top-cover and root growth that prevent erosion and increase humus in the soil.

The legumes are basic in soil improvement, and for pasture and forage purposes they rank high as sources of protein, calcium, phosphorus, and vitamins. This family is represented by the pea, bean, alfalfa, and clover. Such plants carry their seeds in pods and have *papilionaceous,* or butterfly-shaped, flowers. The black locust and coffee-bean tree are among the largest of the leguminous plants. White clover is recognized as one of the smallest. Alfalfa, red and alsike clover,



Courtesy of Omaha Stockyards, Omaha, Nebraska

The livestock supply that feeds into the Nation's great stockyards depends on adequately maintained ranges and pastures and an abundance of hay and grain. Good soil conservation practices protect farm and city prosperity.



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Community cooperation in soil conservation practices in an established soil conservation district.

sweet clover, lespedeza, soybeans, cowpeas, peas, and peanuts are legumes of great importance in our agriculture.

The family *Solanaceae* includes the tomato, the potato, and tobacco. The deadly nightshade is also included in this group but apparently the poisonous quality of the deadly nightshade is not possessed by the tomato and potato. These plants have succulent stems, broad leaves, and pulpy, seed-bearing fruits.

The family *Cruciferae* includes such important cultivated plants as rape, cabbage, kale, and kohlrabi, characterized by broad and succulent leaves which sometimes form into heads.

SUGGESTIONS

1. Whenever terms such as those described in this chapter are used attention should be given to the meaning of the words. Make lists of such words and their meanings. Place emphasis upon using the correct terms. Formulate tests which will determine the knowledge individual students have of the terms.
2. Secure from your county agricultural agent information concerning the program to encourage the growing of soil-conserving crops.

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CHAPTER IV

THE GROWTH AND MATURING OF CROP PLANTS

For what things a man shall sow, those also shall he reap. GAL. VI-8

An understanding of the reasons for the crop-production practices employed by farmers depends on a knowledge of the nature and the growth of plants. During crop-growing seasons, many problems may arise which are due to changes in soil condition, rainfall, and other growing conditions. In order to meet the problems caused by these changes, farmers need to use basic information in making the proper adjustments. A knowledge of how plants feed and grow is essential in determining the practices to be followed in handling the soil, fertilizing the crop, planting, cultivating, harvesting, and storing. With these things in mind it seems important to suggest that every student of agriculture should be interested in knowing about the growth and maturing of crop plants.

Start with the Seed. Since corn is grown over wide areas of the United States it will be used as the chief example for this study. Seed of other crop plants may be used but the principles are essentially the same. An examination of a dry kernel of corn will reveal that one side of the kernel is smooth, whereas the other side shows a depressed or hollowed area. This depressed area is the *embryo* or *germ* of the kernel. In the embryo there is a young plant which will grow if given the proper conditions. The embryo of the kernel contains certain *factors,* or *genes,* as the plant breeder calls them, which have been inherited from the parent stalks. The genes

in the corn embryo will determine to a large extent the type of corn plant which will be produced.

A corn kernel may be easily examined in some detail after it has been soaked in water for about twenty-four hours. If a thin slice is shaved from the embryo side of the kernel it will be possible to locate a small growing point, pointing toward the crown or top of the kernel. Another growing point, which points toward the tip of the kernel, can be found. The point toward the crown of the kernel is called the *plumule* and, if given an opportunity, will develop into the corn stem or *stalk*. The other growing point is called the *caulicle* or *radicle*, and from this develops the first roots of the corn plant, known as the *primary* or *temporary roots*. The *embryo*, or the *germ*, may be easily removed from a kernel of corn which has been soaked. When the embryo is taken out there will be left the part of the kernel known as the *endosperm*, together with its thin coverings. The endosperm consists of starch. In the dent corn, the top or crown of the kernel will appear to be white and rather soft. This is known as the *starchy endosperm*. Along the sides of the kernel it will be noted that the starch has a hard or horny texture. This part of the kernel is known as the *horny endosperm*. See the accompanying illustration for a description of the parts of a corn kernel.

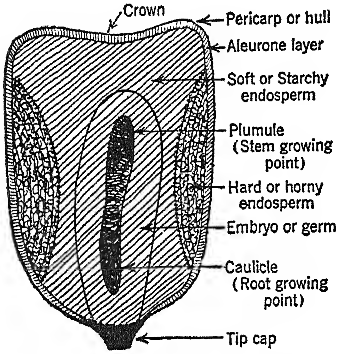


Diagram of a corn kernel.

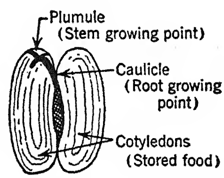


Diagram of a bean seed, typical of seeds of the legume family.

Corn belongs to the grass family of plants. It will be found

that the seeds of other plants belonging to the grass family are similar to the corn kernel or seed in their essential parts. Wheat, oats, barley, timothy are examples of grass family plants.

Since such crops as alfalfa, peas, beans, and the clovers are very important from an agricultural standpoint and are members of the legume family of plants, some time should be spent in examining the seeds of such plants. Instead of having an endosperm the seeds of legume plants have plant food stored in *cotyledons*. See the accompanying illustration. By examining some beans and peas which have been soaked it will be possible to compare them with the corn kernel which represents the grass family plant. After beans or peas have been soaked a short time it is easy to remove the outer covering or testa. When the two halves or cotyledons are pulled apart the plumule, with its small or embryonic leaves, and the caulicle will be found near one end and between the edges of the cotyledons.

Germination of Seed. When corn kernels or other seeds which are in good growing condition are given sufficient moisture, plenty of air, and the right temperature they will *germinate* or *sprout*. If other conditions are satisfactory, the sprouting seed will establish itself in the soil and eventually become the mature plant. An attempt to germinate some kernels of corn in an ice box will show that, even if all other conditions are right, the low temperature will prevent the corn from sprouting properly. Such a condition might be compared to planting corn in a cold soil early in the spring. Corn kernels often rot when an attempt is made to germinate them under cold conditions.

If corn kernels are placed under conditions where it will be impossible for them to get air, the kernels will not sprout because the germinating seed must have oxygen for sprouting and growing. Under field conditions, sometimes, sprouting seeds are deprived of air when the surface of the seed bed crusts after heavy rains.

Moisture in sufficient quantities must be present in order to start the processes within the corn kernel which give the embryo the food it needs from the endosperm or cotyledons. It can be concluded from an examination of germinating seed that proper conditions of air, temperature, and moisture must be provided in the seed bed if a crop is to have the right start. Crop seeds vary to a large extent in their temperature requirements for germination.

Table 1 gives the approximate minimum, or lowest, temperature and the optimum, or best, temperature for the germination of certain crop seeds.

TABLE 1

Approximate Minimum and Optimum Temperatures (Fahrenheit) for Germination

Kind of Seed	Minimum	Optimum
Corn	45	105
Oats	35	80
Barley	40	82
Wheat, rye	40	82
Red clover	35	82

The study of seeds which have germinated should be supplemented by examination of specimens of young corn, bean, and pea plants which have been grown for a short time in sand. Such plant specimens may be compared to the drawings shown below.

A Growing Plant Needs These Elements. A kernel of corn contains enough plant food to give the new plant a start. The food which a plant requires must be made available to it if it is to grow into a mature plant. Chemists have found that the following elements are particularly essential to plant growth: C, carbon; H, hydrogen; O, oxygen; P, phosphorus; K, potassium; N, nitrogen; S, sulphur; Ca, calcium; Fe, iron; Mg, magnesium; B, boron; M, manganese; Cu, copper; Zn, zinc.

These elements may be thought of as building blocks, or units, which the plant has the power to put together in various combinations. The various combinations of these chemical elements manufactured by the plants are the different plant products which will be presented and classified later in this chapter.

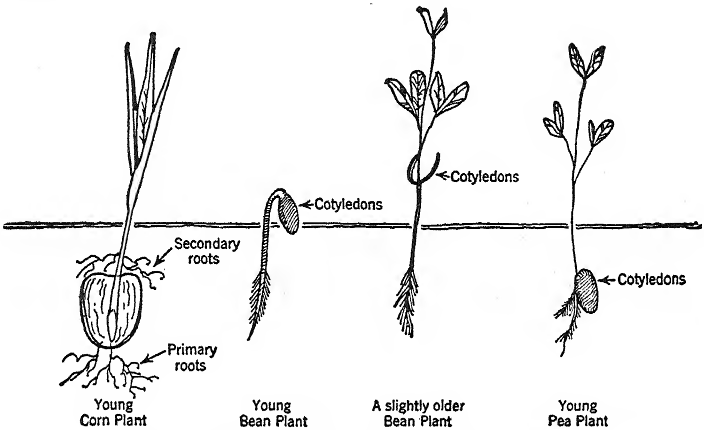


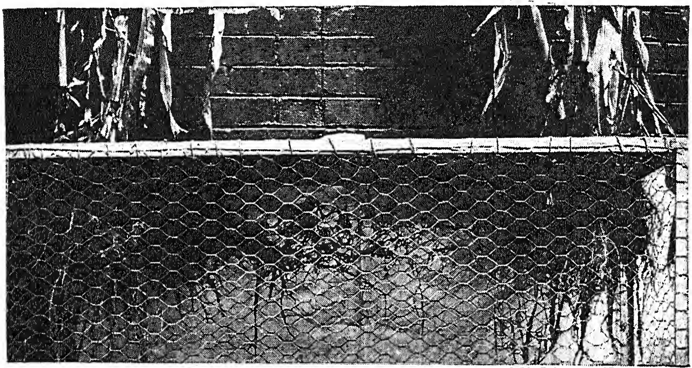
Diagram showing how young plants start growth.

Plants obtain their food from air, water, and soil. The air supplies carbon and oxygen in the form of carbon dioxide for the plant-manufacturing processes and oxygen for plant respiration or breathing. Under natural conditions nitrogen from the air can be used by plants only after it has been taken from the air by bacteria living upon the roots of plants belonging to the legume family or by other nitrogen-fixing bacteria living in the soil.

Water furnishes two chemical elements, hydrogen and oxygen, and the other elements which plants use in the growing process are obtained from the soil.

How Plants Gather Food Materials. Root hairs are very small hair-like growths which occur near the growing tip of a root. They are so fine that they appear something like grow-

ing mold. The root hairs have very thin cell walls. When such root hairs are surrounded with the moisture of the soil in which are dissolved the plant-food elements found in the soil, the soil solution passes through the thin cell walls into the sap of the plant inside the root hairs. This process is called *osmosis*. The plant sap within the root hairs is thicker or more concentrated than the soil solution outside. When two



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The roots of the corn plant fill the soil to plow depth with fine feeding roots and send stronger roots to a depth of several feet.

such solutions are separated by a membrane or cell wall, the less dense solution passes through the cell wall into the thicker solution. It is by this process that the plant food from the soil, after it has been dissolved in water, finds its way into the roots of the growing plant.

Plants give off moisture through openings in their leaves. This process is called *transpiration*. An examination of a leaf with the aid of a microscope will show that there are many small holes or pores in the leaf surface. These pores are called *stomata*. The stomata open and close to a certain extent, depending upon moisture conditions within the plant. During dry periods, conditions cause the stomata to close through a partial collapse of certain cells and thus prevent excessive loss

of water. It is through the stomata that air containing carbon dioxide enters into the leaves of plants.

By the various means just described, it will be seen how plants obtain the various chemical elements which they use in manufacturing plant products. The next step is to describe something of the manufacturing process which goes on within the plant.

How Plant Food Is Used in the Growth of Plants. Plants produce carbohydrates, or products containing carbon, hydrogen, and oxygen in certain proportions, by a process called *photosynthesis*. Since *photo* refers to light and *synthesis* to the "building up" of a compound, the word photosynthesis may be thought of as the building of plant compounds or products with the aid of light. Photosynthesis goes on in plants only when there is a supply of chlorophyll (the green coloring matter in the leaves and stems of plants), sunlight, and plant food, and the proper conditions of moisture and temperature for growth. Most of the formation of carbohydrates occurs in the leaves, and as the process goes on oxygen is given off as a by-product. During the daytime, growing plants give off more oxygen than is used in plant breathing. At night, plants use oxygen in breathing and do not give off oxygen, photosynthesis having stopped because of the lack of light.

The *carbohydrates,* as they are produced by the plants, are used in making growth or are stored in certain portions of the plant, for example in the endosperm of the corn kernel or in the tuber of the potato plant.

The carbohydrates produced by plants are of various kinds.

Simple sugars. Such sugars consist of carbon, hydrogen, and oxygen in the simplest combined form. Glucose, which makes up a large proportion of corn syrup, is an example of this type of sugar.

Sucrose. Sucrose is more complex in its combination because it contains more of each of the three chemical elements

found in a carbohydrate. The sugar obtained from sugar cane and sugar beets is a good example of this type of sugar.

Cellulose. Cellulose is possibly the most complex type of carbohydrate. The structure of the stems and leaves of plants consist of cellulose. Cotton fibers are practically pure cellulose. Wood is a very common form of this type of carbohydrate.

Fats. Plants formulate compounds from carbon, hydrogen, and oxygen which are known as fats. The oils from soybeans, flax, and corn are this type of carbohydrate.

Proteins Produced by Plants. In addition to carbohydrates, plants manufacture products known as *proteins.* Proteins are extremely complex in their structure. They consist of all the plant-food elements which plants take in from soil, water, and air. The gluten found in wheat is a good example of a plant protein. The fact that green plants contain large amounts of protein explains why green grass is such an excellent feed for milk production.

Plant proteins are of great importance because they furnish the chief material for animal growth. The muscles and bones of animals are made from the elements obtained from plant sources. Plant proteins contain the minerals and vitamins needed by animals. Plants of the legume family are especially good feed crops because they contain a higher percentage of protein than crops belonging to the grass family. Alfalfa, for example, has a much higher protein content than timothy. Linseed oil meal, cottonseed meal, and soybean meal contain a high percentage of plant protein and therefore are very useful, especially in feeding cattle.

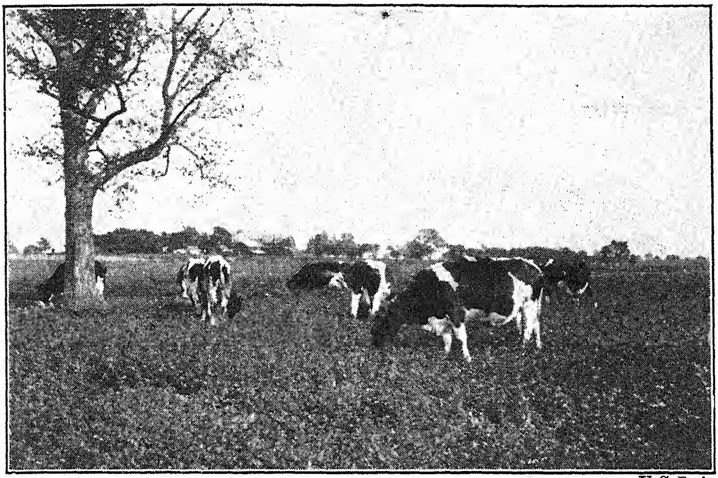
Vitamins. In addition to carbohydrates, fats, and proteins, plants produce substances called *vitamins* which are of very great importance to the health of animals and of people eating the plants.

The various vitamins are as follows:

Vitamin A is found in green leaves and young stems. Yellow corn, carrots, and sweet potatoes are rich in this vita-

min; white corn, grains, and Irish potatoes have a very low content. Butter, cream, and milk contain large amounts of vitamin A. It is also found in cod-liver oil, eggs, and liver.

Vitamin B is made up of various substances found in grasses, legumes, hay, and the leaves of growing legumes.



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Good pasture supplies an abundance of vitamins, mineral salts, and other nutrients and contributes much to the health of animals and human beings consuming milk and meat produced largely from pastured livestock.

Some of the vitamin B materials are found in varying amounts in most grains.

Vitamin C, found especially in such fresh fruits as lemons and oranges, in tomatoes, raw cabbage, and certain other vegetables, prevents a disease called scurvy.

Vitamin D is important in preventing a bone weakness, called rickets, in children and young animals. This vitamin is present to some extent in hay and pasture crops, cod-liver oil, eggs, and milk. Certain products exposed to ultra-violet rays seem to develop or take on characteristics of vitamin D.

Vitamin E seems to be necessary in feeds for animals if normal reproduction is to take place. Green grasses and clover and legume hays contain abundant supplies of this vitamin. It is also found in many of the grain feeds.

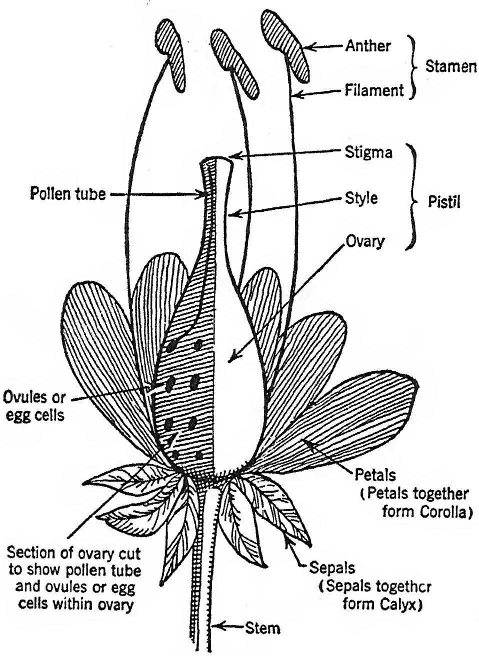
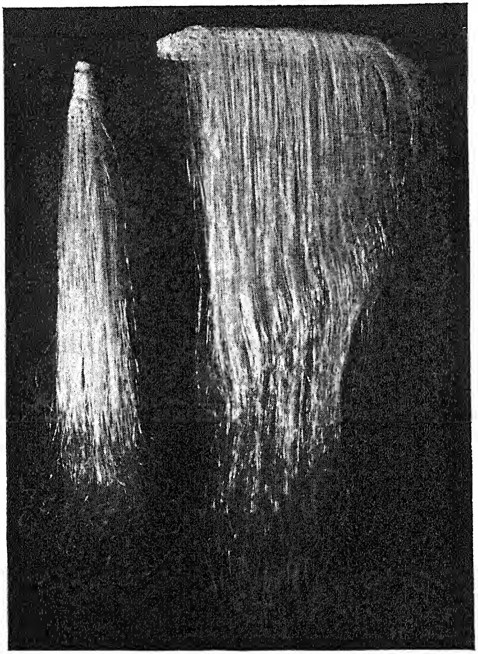


Diagram of simple flower.

Vitamin G is found especially in pasture crops and in well-cured legume hay. This vitamin seems to be needed for animals to make good growth.

How Plants Reproduce Themselves. When plants such as the corn plant have made a certain amount of vegetative growth, consisting largely of roots, stems, and leaves, there appear the parts of the plant which are designed to bring about reproduction, or the carrying on of the plant life. Most crop plants produce *flowers* which correspond to the flowers

of what are known as the flowering plants. In some of the crop plants, especially those of the grass family, the showy part of the flower or the *petals* are not produced. In order to understand the essential parts of a flower it is well to pull apart



The silks or stigma of the corn plant.

such flowers as the pea bloom, nasturtium, or some other available type of simple flower. After the outer portion of such flowers has been removed, it will be easy to see the *stamens* and *pistils,* as shown in the diagram on the facing page. The pistil is the female part of the plant, consisting of the *stigma, style,* and *ovary.* Within the ovary are contained the egg cells or *ovules.* The stamens form the male parts of a flower. Each stamen consists of a stem-like structure, called the *filament,* and the *anther.* Within the anther are found the *pollen grains.*

Anthers burst open when ripe, thus releasing the pollen grains. Gravity, wind, and insects are agencies which carry pollen grains to the stigmas of flower pistils. In some plants the stamens are so arranged that the pollen grains fall from the anthers to the stigma. The stigma is the portion of the pistil which receives the pollen grains. Pollination is the process whereby pollen grains are placed upon the stigma of the pistil. If conditions are right, the pollen grains which fall on the stigma germinate much as a seed does. A tube begins to grow from the pollen grain down through the style and on into the ovary. This tube, known as the pollen tube, continues its growth until it reaches the ovule, or egg cell, within the ovary. When the pollen tube reaches the egg cell, certain cells from the pollen grain unite with the egg cell or ovule. This process is called *fertilization.* After fertilization occurs, the seed is produced, provided the plant has a normal opportunity for growth and development.

Crop Plants Vary in Their Flowering Habits. In some plants the male parts of the flower are produced on one part

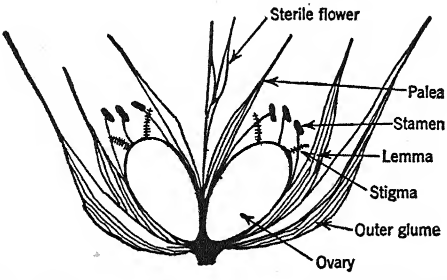


Diagram representing a flower of the grass family.

of the plant, and the female portions of the flower are produced on another portion of the plant. Such plants are called *monoecious.* Corn is one of the best examples of a monoecious plant. The pollen grains are produced in the tassel, which is the staminate portion of the flower. The ear, with its silks, represents the pistil of the corn plant. Each corn silk pro-

vides a stigmatic surface on which pollen grains may fall. In another type of plant the male parts of the flower are produced on one plant and the female parts on another plant. Such plants are *dioecious*. Hemp, asparagus, and certain varieties of strawberries grow in this interesting manner. Wheat, barley, and oats are called *hermaphroditic* plants because both male and female parts are contained within one flower. Such crop plants are usually *self-pollinated,* that is, the pollen grains from the anthers fall on the stigma of the same flower. A diagram of typical grass flowers is presented above.

Some Crop Plants Reproduce without Producing Seed. When plants produce seed which has resulted from the process of producing flowers, the reproduction is said to be sexual. Some of the important crop plants, however, are produced by another process called *vegetative* or *asexual* reproduction. The potato is a good example of such a crop plant. Flowers are not essential in the production of potatoes. Some varieties of potatoes have very few flowers, and only once in a while is potato seed produced from flowers. Any crop which is reproduced by tubers, roots, slips, or cuttings instead of seeds resulting from flowers is said to be reproduced asexually.

The Life Cycles of Plants. Plants have various habits which affect the length of time they will grow. Some plants live through one growing season of a few months; others may live for periods of years. Plants may be classified according to the length of their growing periods.

Annuals. Plants which complete a cycle from seed germination to seed production within one year, or growing season, are called annual plants. In other words, it may be said that such plants complete their life history within a year. All the grains, such as corn, wheat, and oats, are good examples of annual plants. Winter annuals start their growth in the fall of the year, enter a somewhat dormant stage during the winter, and complete their growth during the succeeding grow-

ing season. Rye and winter wheat are good examples of winter annuals.

Biennials. Biennials are plants which complete their life history in two years. During the first year of growth the plant manufactures food which is stored, in roots, tubers, or other parts of the plant, in such a manner that the growth of the plant will continue during the following growing season. During the second growing season such plants produce seeds. The process of growth from seed germination to seed production requires two growing seasons. Cabbages, carrots, turnips, and beets are examples of such crops.

Perennials. Perennials are plants which continue their growth, if conditions are right, for an indefinite length of time. Such plants often produce seed each year, but they also store plant food in roots or underground stems in such a manner as to provide a means of starting growth after they pass through a dormant period. Alfalfa is a perennial plant. Weeds, like Canada thistle and quack grass, are long-lived perennials.

Maturity of Crop Plants. From the standpoint of plant life, maturity refers to the time when the plant has produced seed or has stored sufficient products to provide for its continued growth. The seeds or the plants, upon reaching maturity, pass through a rest stage or period of *dormancy* before they are ready to continue growth. From the standpoint of the use of plants by farmers, *maturity* means that the plant or its products have reached the stage at which they will be most useful as far as the farmer is concerned. For example, plants may be mature for purposes of making a hay of good quality long before they are mature from the standpoint of producing seed.

Application of the Facts in This Chapter to Farm Practice. If the farmer knows something of the nature of seed, he will realize what he needs to do in order to store seed properly. Since each kernel of corn, for instance, contains a living plant it becomes important to handle the seed with care in order that the life may be maintained until such time as it is to be given

an opportunity to develop. If the farmer has knowledge of the conditions which are necessary for seeds to germinate, he will be guided in the preparation of suitable seed beds and in the performance of other practices which promote the proper germination of the seed. Knowledge of the needs of plants for certain plant-food elements gives the farmer a better understanding of the problems of fertilization. As a result of knowing how plants reproduce he will be able to adjust practices in such a manner as to promote good seed production.

The intelligent feeding of livestock depends upon an understanding of the nature of products produced by plants and how these need to be combined in the economical production of livestock products.

SUGGESTIONS

The purpose of this chapter is to aid in the development of an understanding of the growth and maturing of crop plants. Such an understanding is fundamental because it forms a basis for making many necessary decisions in successful crop production.

Students and teachers should supplement this chapter by using some of the following suggestions.

1. The growth and maturing of crop plants should be studied near the beginning of the school year in order that the information may be used throughout the subsequent study of crop management and soil conservation.

2. Bring to the classroom crop plants and seed samples to be examined as suggested in this chapter.

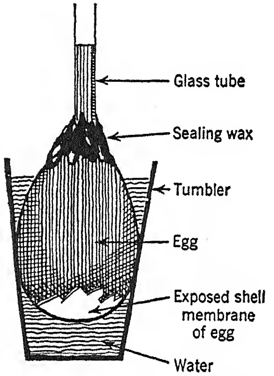
3. Plan to have available for study seeds which have been soaked twelve to twenty-four hours, well-sprouted seeds, and young plants a few inches high which have been grown in sand boxes.

4. Try sprouting seeds in an ice box, under water, in a closed can or jar, or under other conditions. Relate the findings to the germinating of seeds under field conditions.

5. Prepare an exhibit of the various chemical elements or compounds which contain the elements needed by plants for their growth. The high-school chemistry department may have the elements or compounds in an interesting form.

6. Prepare a demonstration of osmosis and relate this to the process by which plant food enters plants through the hair roots.

Osmosis may be demonstrated by proceeding in the following manner: Carefully tap the large end of an egg until the shell is seen to be broken into small pieces. With the blade of a knife or with the nail of the forefinger, loosen and remove the fragments of egg shell, being careful not to break the egg membranes found just under the shell. Clear an area about half an inch in diameter. When this is completed, drill a hole through the small end of the egg just large enough to permit the insertion of a piece of glass tubing of small diameter. When the hole has been drilled, stir the contents of the egg with a wire or sharp instrument so that the yolk will be broken and the yolk and white of the egg will be mixed somewhat. Be very careful not to break the egg membrane where the shell has been chipped off. If the egg is placed in the mouth of a milk bottle it is easily held in position while a length of glass tubing is fastened in the hole made in the egg. The tubing may be securely fastened and the hole in the egg around the tubing closed by common red sealing wax. When this is completed the egg may be placed in a tumbler or glass, wide enough at the top to permit the egg to be placed well down in the receptacle but narrow enough in diameter toward the bottom to prevent the egg from touching the bottom. The sides of the tumbler will thus support the egg and the glass tube. Fasten the tube to a stand so that the apparatus will not tip over. Fill the tumbler with water. In a short time it will be possible to observe the contents of the egg rising in the glass tube, thus demonstrating the entrance of water into the egg through the membranes of the egg.



A chipped egg, membrane at bottom unbroken, and shell pierced by glass tube sealed at top, will effectively demonstrate osmosis when immersed in a tumbler of water.

7. Assemble samples of the various compounds manufactured by plants, such as the various carbohydrates, fats, and proteins.

8. Be sure to pull apart different types of simple flowers in order to become familiar with their parts. Use a razor blade to cut various parts in order that a more detailed examination may be made. Examine with a low-power microscope.

9. Certain chapters in elementary botany or biology books should be examined for useful facts and for suggestions for setting up various

demonstrations having to do with osmosis, transpiration, and other plant-growth processes.

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CHAPTER V

THE NATURE OF SOILS

Where grows?—where grows it not? If vain our toil we ought to blame the culture not the soil.
POPE

If profitable crop yields are to be obtained, the soil must be managed efficiently. Every farmer needs to study the soils of his farm in detail because information about the soil is necessary in order to make the decisions which will result in satisfactory crop growth. Without an adequate knowledge of the soil he has to work with, a farmer is seriously handicapped and will often make costly mistakes. The slope of fields, native and cultivated cover, the humus content, fertility and character of soils, rainfall and snow cover are important factors to consider in planning essential soil conservation and fertility-maintenance programs for each farm. The soil is a remarkable substance, and it has exceedingly interesting characteristics.

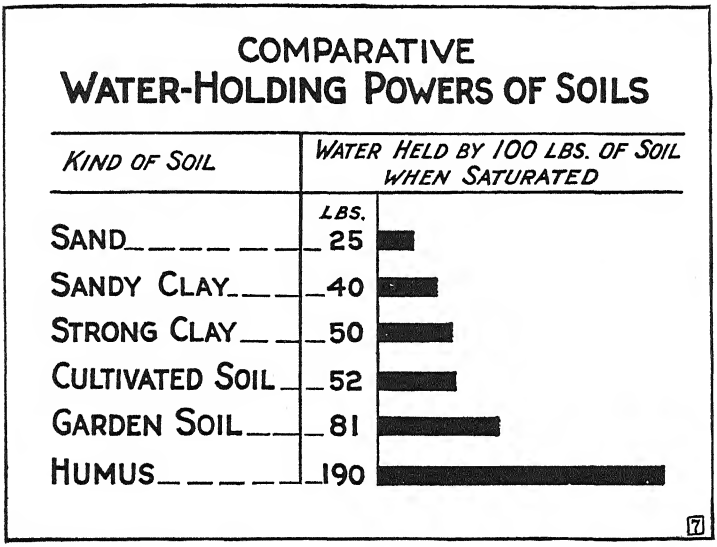
Although the soil may appear to be dead and inert, as a matter of fact, in addition to the life aboveground, there are to be found within the soil, working below the surface and affecting its structure, all the major forms of life. Insects, worms, mammals, reptiles, small plants, fungi, bacteria, and protozoans live in the soil and aid in its development.

The nature of soils is considered under the following headings:

1. A simple soil classification.
2. Soil classification based on formation and topography.
3. Chemical nature of soil.
4. Life in the soil.
5. Soil moisture.

6. Good soil management depends upon knowledge of the characteristics of soil.

A Simple Soil Classification. The term light soils is commonly used to refer to soils that are sandy and easily worked; heavy soils, to sticky fine-grained clay soils, which are hard



A.A.A., U.S.D.A.

Soils vary greatly in their capacity to hold water. Humus greatly increases water-holding capacity.

to plow and prepare. Between these extremes there are a variety of soils, such as sandy loams, loams, silt loams, clay loams, and muck soils carrying varying amounts of organic matter.

Sandy and gravelly soils are made up largely of more or less coarse particles of sand or sand and gravel. They are usually droughty, generally deficient in organic matter and the available elements of fertility, and they require careful management for profitable production. The surface soil, or

portion discolored by organic matter, is usually shallow, generally from 3 to 5 inches in depth. The under soil, or sub-soil, shows little discoloration due to organic matter. Such soils should be plowed to shallow depth.

Sandy loams and gravelly loams carry a higher percentage of fine soil material. They are more fertile and more retentive of moisture and are often favorable to a high development of special crop production. As a class, they respond to methods which increase their content of organic matter.

Loams are soils of an intermediate nature, made up of both coarse, sandy particles, and fine, silty, or clayey particles. Such soils work fairly easily and are generally fertile and retentive of moisture. The surface layer discolored by organic matter is usually deeper than in lighter soils, often being 5 to 7 inches or more in depth.

Silt loams have a finer texture and smoother feel than loams and carry a higher proportion of fine material. They are usually more fertile and moisture-retentive.

Clay loams are heavier and stickier than silt loams, and they carry a larger percentage of very fine soil particles or clay. They are more often benefited by tile drainage.

Clay soils are plastic, very fine-grained, and sticky. They are made up of a large percentage of very fine soil particles or clay. They must be worked at just the right time for good results in tillage operations. They have large water-holding capacity and generally poor underdrainage.

Muck soils are very high in organic matter and generally loose and light in structure. They are benefited by the use of heavy rollers or cultipackers in preparation. Such soils are of marsh formation and generally need drainage.

Soil Classification Based on Formation. Soils are made up of mineral matter or rock particles, and vegetable matter or humus. They are formed by physical, chemical, and biological activities.

Residual soils are formed in place from the underlying rocks. Soils formed from sandstones are usually sandy, whereas soils

from limestone are generally loams, silt or clay loams, or clays.

Alluvial soils are those formed by the deposition of soil particles by streams, or in lake bottoms. Bottomlands and lake-bed soils are typical examples.

Glacial soils are those formed and deposited by the ice and water of the great ice sheets, which, during the Ice Age, worked almost as far south as the Ohio River. The presence of round boulders and glacier-scarred rocks marks glaciated localities.

Soils of very fine texture, deposited by wind action, are known as *loess.* Such soils occur in the western part of the Mississippi Valley.

Swamp or *cumulose soils* are formed by the accumulation of decaying organic matter from the plant growth in swamps and bogs.

Chemical Nature of Soil. The soil particles and the decaying vegetable and animal matter in the soil are made up of various chemical elements. As described in Chapter IV, plants obtain from the soil many of the chemical elements needed for growth. If the soil does not contain the proper elements for plant growth, these elements must be supplied by the farmer. The principles and practices of fertilizing crops are presented in Chapter VII.

Life in the Soil. Bacteria and fungi are present whenever the soil contains organic matter in the form of decaying plant and animal matter. The bacteria that live in the soil play a very important part in helping to make plant food available for plant growth. The chemical elements found in the rock or mineral portion of the soil must be released or made available in a form useful to growing plants. Plant and animal material must be broken down and formed into chemical compounds which the plant can use. These processes are carried on by bacteria and other such low forms of life that live in the soil. Part of the farmer's job is to handle the soil in such a manner as to promote the development of bacterial action. When the top soil is washed or blown away the farmer not only loses

the soil particles but also the bacterial life which is so important in making a soil fertile. Sub-soil is less productive because the organic matter with its associated bacterial action is not present.

Soil Moisture. The moisture which is contained in a soil is a very important part of the soil as far as plant growth is

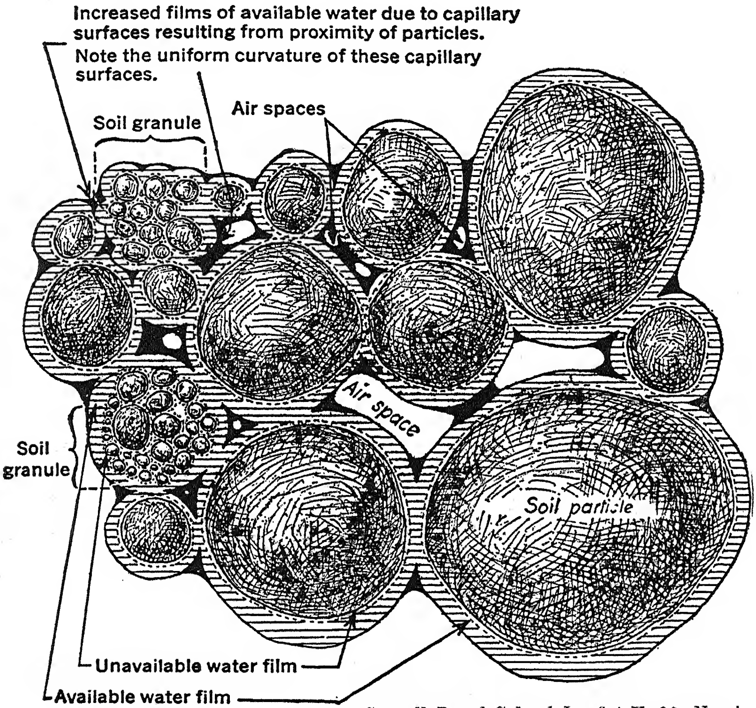
A newly turned alfalfa sod. Alfalfa, clover, lespedeza, and sweet clover, turned under, increase the content of organic matter and nitrogen in the soil. These legumes are among the most valuable nitrogen gatherers.

concerned. In Chapter IV it was pointed out that plant food gains entrance to plants through the roots by being dissolved in water. Water is found in soils in various forms.

Hygroscopic Moisture. Soil which is air-dry contains a certain amount of water. This can be demonstrated by heating air-dry soil and noting the loss in weight or by holding a piece of glass over the soil being heated and noting the gathering or condensation of moisture on the surface of the glass.

Such moisture, known as hygroscopic moisture, is held by the surface of soil particles so closely and firmly that plants cannot obtain it from the soil. In extreme drought about the only moisture found in the surface soils is hygroscopic in nature. Plants wither and die if only such moisture is present.

Capillary Moisture. When water evaporates from the surface of the soil more moisture will tend to move to the surface. Such moisture moves to the surface by capillary action. The



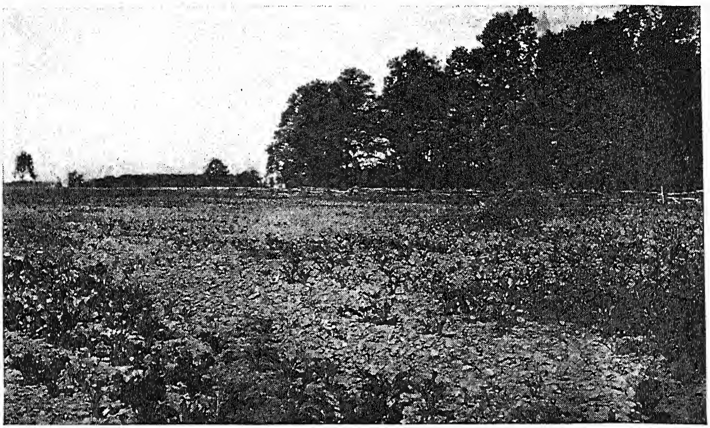
Cornell Rural School Leaflet V. 29, No. 4

Plants make use of water surrounding soil particles in well-drained and well-aerated soils.

surfaces of soil particles have an attraction for water. This attraction is called capillary attraction. As a result of it, each soil particle is surrounded by a film of moisture known as capillary moisture. In penetrating the soil the roots of plants come in contact with the capillary moisture. Dissolved in the capillary moisture are the various chemical compounds which, when taken into the plant through the root hairs, become the

material used by the plant in its growth processes. Capillary moisture is the type of moisture in the soil which is of most importance in plant growth.

Gravitational or Free Water. As mentioned above, capillary moisture is held around the soil particles by capillary attraction. When there is more water than can be held in the soil



A sugar beet field showing failure of stand due to poor drainage.

by capillary attraction, such water tends to drain or flow downward because of gravity until it reaches a level below which it cannot flow. This level is called the water table. Below it the pores of the soil are filled by water. The water table varies in relation to the surface of the soil according to the soil drainage conditions and the rainfall. In some soils the water table is very near the surface, and in low spots the level of the water may be above the surface of the soil, when water is said to be standing on the land or soil.

Free or gravitational water is very injurious to crop plants if it occurs very near the surface of the soil. Such water prevents air from entering the soil, and the roots of crop plants need air for their development. If the soil contains excessive

amounts of gravitational water, drainage systems must be provided if crops are to be raised successfully.

Good Soil Management Depends upon Knowledge of the Characteristics of Soil. Knowledge of the type of the soil enables one to select suitable soil management practices. A heavy clay soil must be plowed, harrowed, or cultivated under the right moisture conditions in order to keep the soil in good condition. Soils that have a tendency to bake or form crusts must be cultivated to break the crust to allow air to enter the soil. Heavy soils with poor drainage need to be drained in order to make good conditions for crop growth. Organic matter in the form of barnyard manure or green-manure crops needs to be incorporated in heavy soils to loosen up the soils, and in sandy or light soils to increase the water-holding capacity of the soil. In dry areas soils need to be irrigated to provide growing crops with capillary moisture.

SUGGESTIONS

1. Secure samples of the soils on home farms or from a particular farm in the community which is being studied. With a soil auger or a spade, secure samples of the surface soil and of the sub-soil. At the time the samples are obtained they should be located upon a map of the field. In connection with the samples notations should also be made concerning such information as the crop or plant growth on the soil, whether taken from hilltops, hillsides, bottomlands, or from comparatively level fields. Any such information will be useful when a classroom study of the soil samples is made at a later date.

2. Dig a pit several feet deep so that it will be possible to study a profile of the soil as it occurs in the field. Note the difference between surface and sub-soil.

3. Secure a soil-survey report and map of soils for your county, if available, from the Bureau of Soils, United States Department of Agriculture, or from your state experiment station. In such a report find the description of the local soils.

4. Compare samples of the same type of soil from cultivated fields and from near-by woods or fence rows where the soil has not been under cultivation.

5. Send soil samples to the state agricultural college for testing in order that the information may be used in determining the needs for fertilizer.

6. Secure from the state agricultural college bulletins or other information describing soil tests which may be made under field conditions or in the high-school classroom.

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CHAPTER VI

PROTECTING OUR SOIL FROM EROSION

Nothing, in my opinion, would contribute more to the welfare of the States than the proper management of the lands.

GEORGE WASHINGTON

The rise of America to first rank among the nations of the world in agriculture and in industry within a little more than a century and a half is without precedent in the world's history. This remarkable achievement has, however, left its mark on the land. As Americans we are justly proud of our national progress, but in the interest of the America of today and tomorrow, we must take careful account of the cost of our prosperity. Although an inventory of our available farming land discloses vast remaining soil resources, it also shows the havoc that has been wrought by the overproduction of fertility-depleting crops and by frequent misuse of our lands. Great wars have required periodically heavy drafts on our soil fertility.

Our agricultural history to date has been largely the history of vigorous and courageous pioneering, followed by a period of extractive farming. Through the development chiefly of machinery and control of crop pests, the highest degree of efficiency in production per man-unit has been achieved.

During the past century and a half, our production has been kept largely on the increase by the opening to settlement in progressive stages of the fertile lands of the Midwest and the West. After extensive areas of once fertile soil had been worn out in a few generations of exhaustive cropping, many Eastern and Southern farmers moved on to the new lands that lay to the west to repeat the process.

Remarkable contributions to efficient farm practice by chemists, agronomists, plant breeders, economists, agricultural engineers, biologists, entomologists, and plant pathologists have been largely offset by decreasing soil fertility due to erosion and extractive farming.

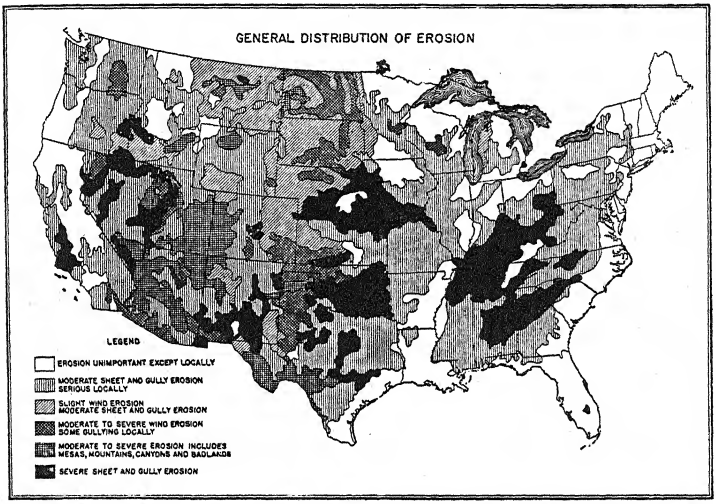
R.A., U.S.D.A.

Poor farming practices rapidly destroy natural soil resources. This picture of a field plowed with the slope shows how uncontrolled sheet erosion soon results in gully formation.

The farmer of today and tomorrow must become expert not only in the efficient production of maximum crop yields per acre as needed but also in protecting his soils from erosion by water and wind, and in maintaining and building up the elements of fertility removed by crops and livestock.

Soil Erosion. Soil erosion is the wearing away of soil by the action of water and wind. Extreme erosion causing the formation of gullies or deep ravines is readily apparent to the eye. Sheet erosion, the gradual washing away of the surface soil by water, is much less apparent and yet is by far the most

wasteful form of erosion from the standpoint of total annual loss. The blowing of the surface soil of the dry regions of the West, like sheet erosion, is more or less evenly distributed over the surface of the area affected, and extensive damage may be done by improper cropping and resultant wind erosion without



U.S.D.A. Soil Conservation Service

Map showing general distribution of erosion in the United States.

the natives of the region becoming fully aware of the serious losses occurring.

Controlling Soil Erosion. The control of erosion varies with conditions and topography but, in general, whether erosion losses are caused by wind or water or both, the major prevention is to keep the ground covered with adapted grasses and legumes that bind the soil. Steep slopes in regions of ample rainfall and soils of dry land areas where rainfall is not sufficient for the growing of grain and cultivated crops should be kept permanently covered with adapted grasses and legumes. Where practical rotations may be practiced, including culti-

vated crops and small grains, legumes, and grasses, the period that any particular field is devoted to meadow and pasture crops may be extended to the benefit of the soil.

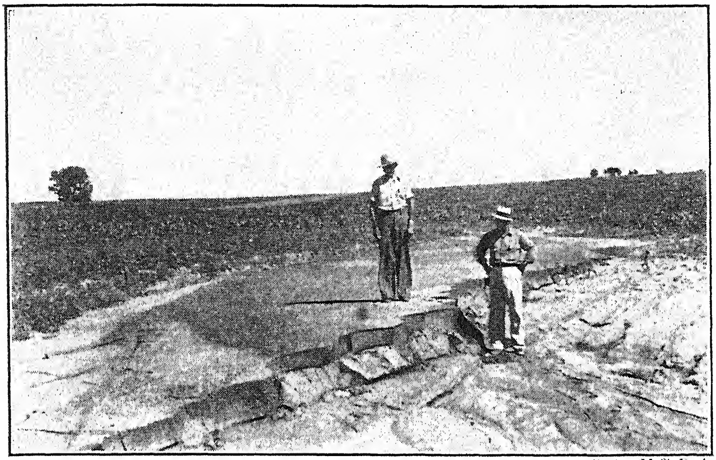
The following operations and practices control erosion:

1. Keep land covered with grasses, legumes, other close-growing crops, and trees.
2. Practice rotation, including increased use of soil-conserving crops.
3. Plant strip crops to reduce run-off and wind blowing.
4. Terrace land on slopes.
5. Fill gullies and plant to soil-holding plants.
6. Plant farm woodlots and windbreaks.
7. Apply special practices where adapted, such as the contour furrowing of pastures and ranges, strip listing, rotation or deferred grazing, and pond construction.
8. Adopt and follow a sound land-use policy to secure our nation's future.

Keep Land Covered with Grasses, Legumes, Other Close-Growing Crops, and Trees. Before the coming of the white man to America, nature prevented erosion by clothing the surface of the land with grass and trees. Man also can effect almost complete control of erosion through proper vegetative measures. The steepest hillsides planted to forest trees or grass are held secure with little loss from erosion. In humid regions, where the slope is moderate, erosion may be kept under control by planting small grain crops in the fall and close-growing crops in the summer season and by increasing the acreage that is allowed to remain for a number of years in pasture. Meadow crops such as alfalfa, lespedeza, sweet clover, clover, other legumes or grasses for permanent pasture, or long-established meadow crops such as bluegrass, redtop, timothy, orchard grass, and other adapted grasses are recommended. The growing of row crops such as cotton, corn, tobacco, and potatoes should be kept to a minimum on eroding land, and these crops should be included in rotations with legumes and grasses that charge the soil with organic matter.

The rows of cultivated crops, of course, should never be with the slope, but should be at a right angle to the slope.

In western regions, where wind erosion occurs, the reestablishment of sods of adapted grasses and legumes will reduce erosion losses to a minimum.



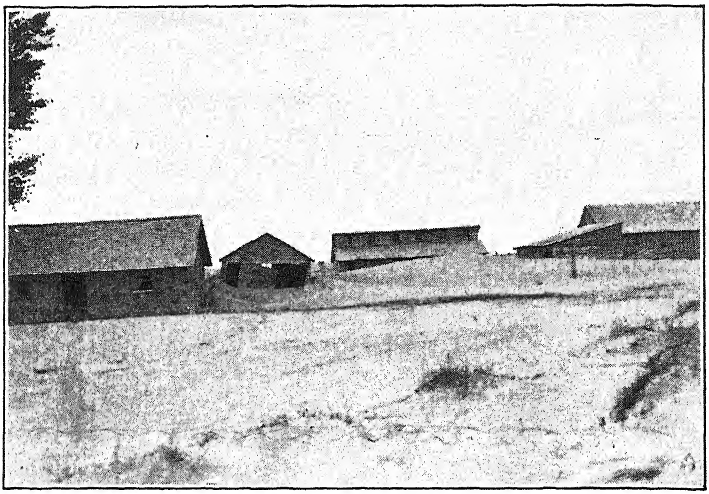
S.C., U.S.D.A.

Sheet erosion causes extensive damage to our most fertile soil.

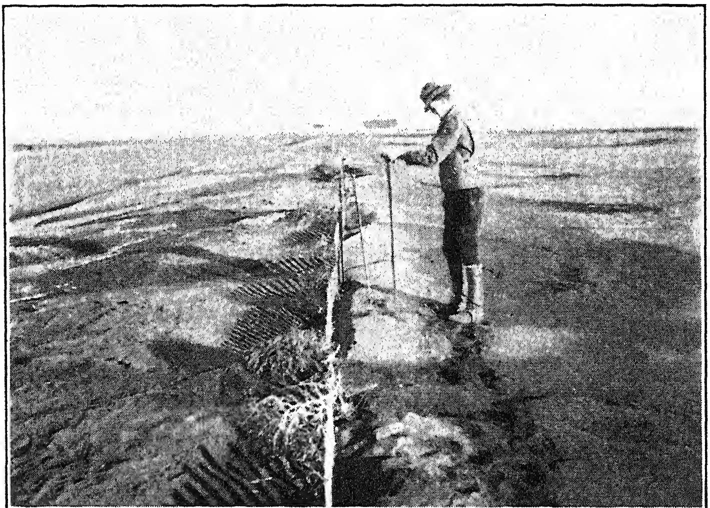
The native buffalo grass of the short-grass region, extending north and south east of the Rockies in a broad strip several hundred miles wide, maintained a sound beef cattle and sheep industry for many years until depleted by overgrazing and plowing for wheat and grain production. When in grass, the country was undamaged by wind erosion, and even severe droughts caused comparatively little suffering.

Soil losses have been excessive during recent droughts, and many thousands of people were forced from the land to other states.

State and federal programs of replanting to buffalo grass, crested wheat grass, slender wheat grass, drought- and cold-resistant alfalfa varieties, such as the Ladak, and other adapted



Soil moving in caused this farmer to move out.



U.S.D.A. Soil Conservation Service

An example of extreme soil drifting in Northwest during drought of 1934.

Drifting soils in western drought region cause great losses. Only established, adapted grasses and adequate erosion control methods can hold down such soils.

cover crops are being encouraged throughout the regions of recurring drought. This is accompanied by a return to grazing after programs of carefully controlled grazing.

TABLE 2

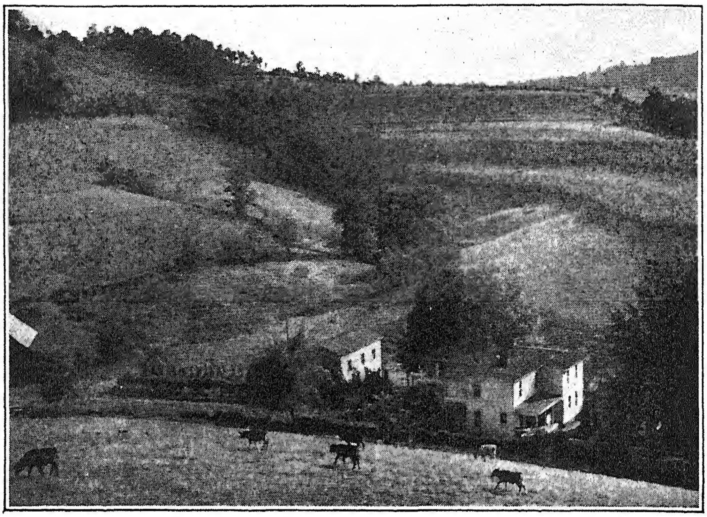
SOIL LOSSES DUE TO EROSION ARE SMALL ON GRASSLAND

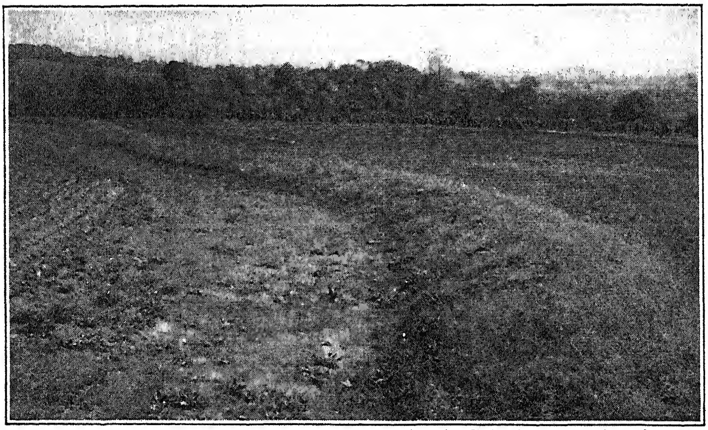
Location	Slope, Per Cent	Soil Losses per Acre	
		Cultivated land, tons	Grassland, tons
Guthrie, Okla.*	7.0	14.6	0.04
Columbia, Mo.†	3.7	19.7	.3
Hays, Kans.*	5.0	16.0	.004

* Data, Bur. Chem. and Soils, U. S. Dept. Agr.
† Data, Mo. Agr. Expt. Sta.

Practice Rotation, Including Increased Use of Soil-Conserving Crops. On many farms it has been the custom to use the best land too constantly in the production of cultivated crops and grains that exhaust fertility and offer little protection against erosion. The planning of rotations that provide for the growing of legumes and pasture and meadow grasses in sequence with the grain and cultivated crops greatly lessens erosion losses and increases organic matter. On most farms in the Corn Belt and Northern States, from 25 to 35 per cent of the cultivated land each year should be in clover, alfalfa, sweet clover, or other meadow and pasture crops that conserve the soil. The percentage in soil-conserving crops should be much higher on farms with large areas of steeply sloping land, infertile, stony, or poorly drained land.

Plant Strip Crops to Reduce Run-Off and Wind Blowing. On sloping land in humid regions where soil is washing away,





U.S.D.A. Soil Conservation Service

Grass and strip cropping on slopes—trees in gullies (above). Terrace following contour (below).

the planting of strips of dense-growing crops along the contours, between strips of cultivated crops, also following the contours, greatly reduces the run-off of water that causes soil loss and increases the penetration and retention of rainwater, and thus increases crop yields. The width of the strips is usually four or five rods, but on steep slopes, the wider the strips of dense-growing cover crop and the narrower the strips of corn or other cultivated crops, the more effectively is erosion controlled.

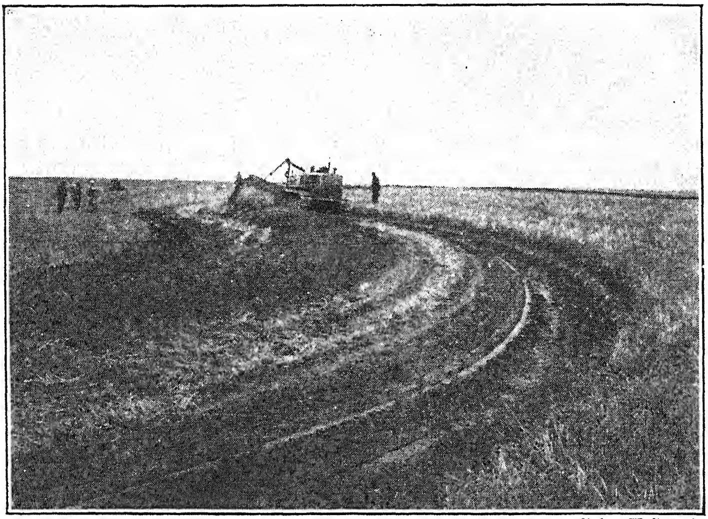
Lespedeza, sweet clover, alfalfa, grass, and legume mixtures, sudan grass, cowpeas, soybeans, and small grains for winter cover or for pasture, hay, or grain are types of crops generally used in accordance with adaptations as close-growing cover crops.

The alternating strips of corn, cotton, potatoes, or other cultivated crops should be planted in rows across the slope so that each row acts also to check and absorb the flow of rainwater.

In regions of moderate or deficient rainfall where wind erosion occurs, the planting of crops in strips at right angles to the prevailing winds greatly reduces wind losses. Sudan grass, crested wheat grass, and oats, grown in strips alternating with sorghum, corn, or other cultivated crops, are effective means of reducing wind injury and causing the deposition of wind-borne soil on the slope. A substantial stubble and stalk cover should be left on the land over the winter.

Terrace Land on Slopes. On sloping soils in the humid area of the eastern half of the United States, terracing is considered a most important means of soil conservation. The Mangum terrace, one of the oldest types in use, is essentially a broad levee of earth 12 to 15 inches high, and 18 to 24 feet broad, following the contours at right angles to the slope. These terraces are at intervals of a few rods to many rods apart according to the steepness of the slope. The effect of this type of terrace is to retard the flow of water and cause it to drop its load of soil particles along the terrace line.

The Nichols terrace, now in general use, consists of a broad, shallow ditch on the upper side with a broad embankment of earth below. It is constructed by scooping out the ditch and spreading the soil to form the buttressing embankment below. Modern terracing has been defined as planned hill-



S.C., U.S.D.A.

Preparing a terrace following contour.

side drainage with banks at intervals to break the force of the run-off water and channels located above the banks to collect the run-off water and direct it gently to controlled outlets, preventing the flow of water from achieving sufficient velocity to erode the soil.

In order to be effective, terracing must be accompanied by a good system of soil management. A cropping system including cover crops and grass in accordance with soil adaptation should be carefully planned. Plowing should be reduced to a minimum, and all furrows when plowed should run parallel

with the terraces and contours. On moderate slopes the terraces are cultivated and planted with the same crops that occupy the field as a whole. On unusually steep slopes, the terraces may be left in grass or planted to drilled or broadcast feed crops that prevent erosion.

The advantages of terraces are summarized by the Soil Conservation Service of the United States Department of Agriculture as follows:

1. They may be cultivated.
2. They check erosion.
3. They conserve rainfall.
4. They reduce the loss of lime and fertilizers by rain.
5. They do not interfere with the operation of ordinary farm machinery.

Although terraces can be constructed by the plow alone, the best terraces are constructed by special terracing machinery drawn by tractors or by county road equipment.

Fill Gullies and Plant to Soil-Holding Plants. Many farmers have seen many acres of their land rendered worthless for farming by expanding gullies which resist efforts to fill them with trees, brush, straw, old wire, or other material. The erosion specialists of the United States Department of Agriculture recommend healing gullies by establishing a protective covering of trees, vines, legumes, and grasses over the surface. They advise the following practices:

In "healing" or stopping the gullies, the necessary steps are (1) construct temporary check dams in the gully to catch up loose soil in which to plant trees, vines, or grasses; (2) slope the banks to an angle of repose (about 3 per cent), which will also serve to put into the gully topsoil necessary for stimulating good growth; (3) plant trees, vines, or grasses selected for their ability to grow quickly and spread their roots in the soil and their tops over the soil; and (4) protect the vegetative cover from fire, livestock, and overcutting. In shallow, short gullies it will often be unnecessary

to build any check dams except at or around the gully head or heads —the most critical point in an active gully.[1]

In accordance with adaptation, sweet clover, lespedeza, grass mixtures of bluegrass, redtop, timothy, orchard grass, and clovers are seeded to the slopes of gullies. Of the vines, honeysuckle in the Central and Northern States and kudzu and honeysuckle in the South are valuable for the steep slopes of deep gullies. Trees, such as black locust, wild thorn, or adapted pines and hardwood, are effective in controlling large gullies.

Such plantings provide excellent protection and feed for song birds, quail, pheasants, and small game.

Plant Farm Woodlots and Windbreaks. Many areas of steeply sloping land, rocky, infertile, or badly gullied soils can best be utilized if they are planted to adapted trees. Erosion losses practically cease in established woodlots, and the slow process of the topsoil formation through the decay of leaves and dead branches begins.

As a source of profit on the farm, the farm woodlot in a few years contributes valuable poles, posts, firewood, and Christmas trees or evergreens for replanting.

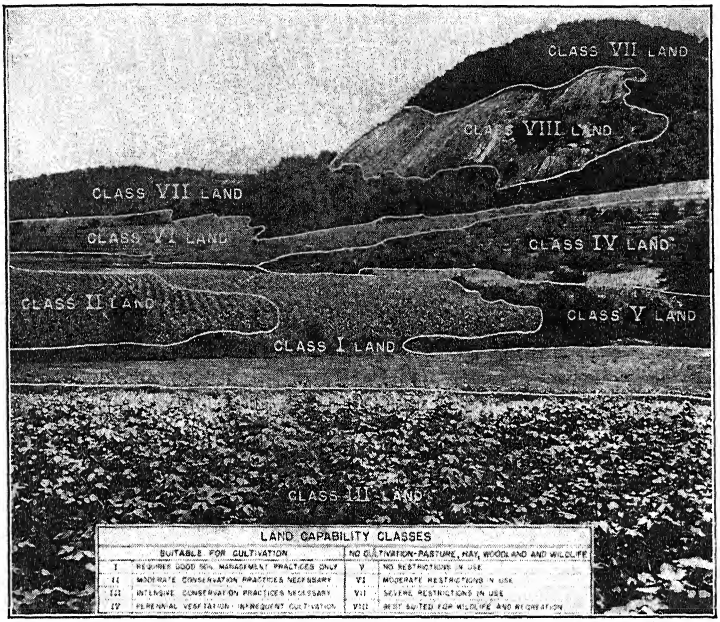
After thirty or more years, timber for beams and post use and an ample fuel contribution may be expected. In a period of forty or fifty years, enough timber is produced on six acres or more of good farm woodland to replace the barn and outbuilding equipment of the average farm.

Plantings of sugar-maple trees in northern localities provide an annual income in maple syrup. Pecan trees in the Southern States and walnut, hickory nut, and chestnut trees in the Northern States will yield an annual crop of nuts as well as supply timber and fuel.

Several acres or more of good farm woodland furnish splendid cover and feed for song birds and game birds valuable in

[1] United States Department of Agriculture, *Farmers' Bulletin* 1937, "Stop Gullies, Save Your Farm."

insect control, and for small game animals. A few nut trees adapted to soil and climate should be planted on the edge of the woodland.



U.S.D.A. Soil Conservation Service

The more fertile and comparatively level fields of this farm are used for growing cash and feed crops in rotation. The gentler slopes are protected by terracing and the planting of grasses and legumes and fruit trees. The severe slopes are used for farm woodlot and wild life purposes.

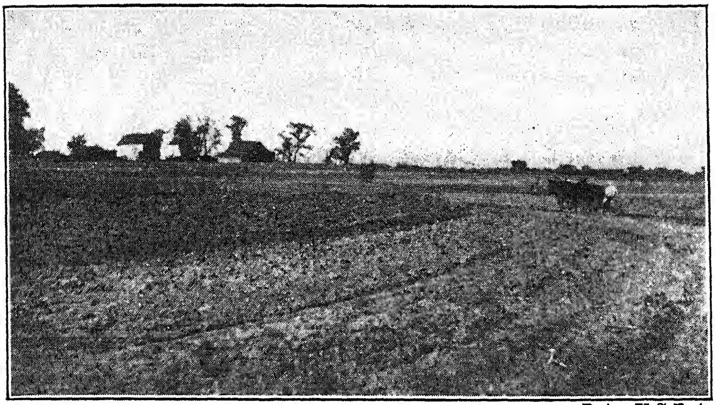
In addition to valuable cash returns, a farm woodlot adds much in the way of enjoyment for the farm family—a place for picnics, wild flowers, nutting, and hunting.

The kinds of trees to be planted depend upon the locality and soil. In New England and the Lake States, spruce, white pine, and red pine are adapted to northern localities and light

U.S.D.A. Soil Conservation Service

Farm woodlots give protection to the farmstead and prevent soil losses from wind erosion.

soils—maple, walnut, and oak on loams and clay loams that previously grew these trees. In the South Central and Southern regions, southern pine, oak, and black walnut are adapted; in Western regions of deficient rainfall, but with enough water in the soil to carry the growth, jack pine, Chinese elm, scrub oak, and cottonwood are among the trees commonly planted.



R.A., U.S.D.A.

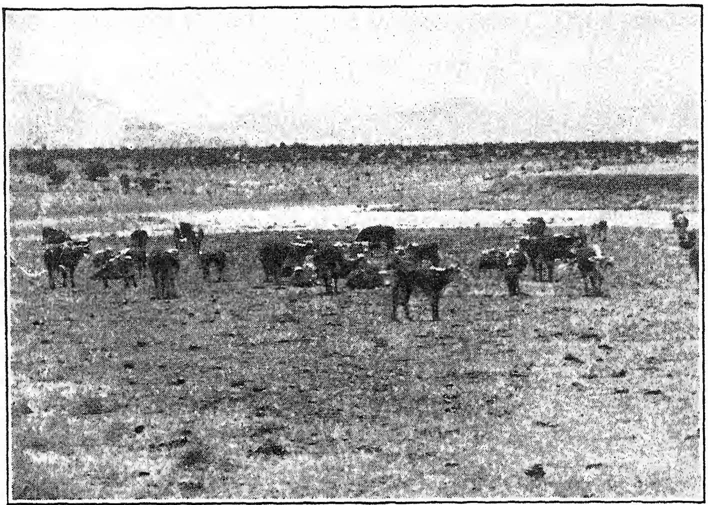
This farmer reduces sheet erosion and prevents gully formation by plowing across the slope or with the contours of his field.

A large percentage of survival of these last-named trees has been reported in the Great Shelter Belt planting extending from the Canadian border in North Dakota into Texas.

Windbreaks of adapted trees planted usually in several rows provide shelter around farm houses and buildings and protect the soils in fields from being blown by high winds.

From 700 to 1000 trees are usually planted per acre and later thinned to a permanent stand. The farm woodlot should be fenced and grazing by livestock prevented in order to permit young trees to get started and new growth to develop in established woodlots.

Apply Special Practices Where Adapted. Such practices as the contour furrowing of pastures and ranges, strip listing,



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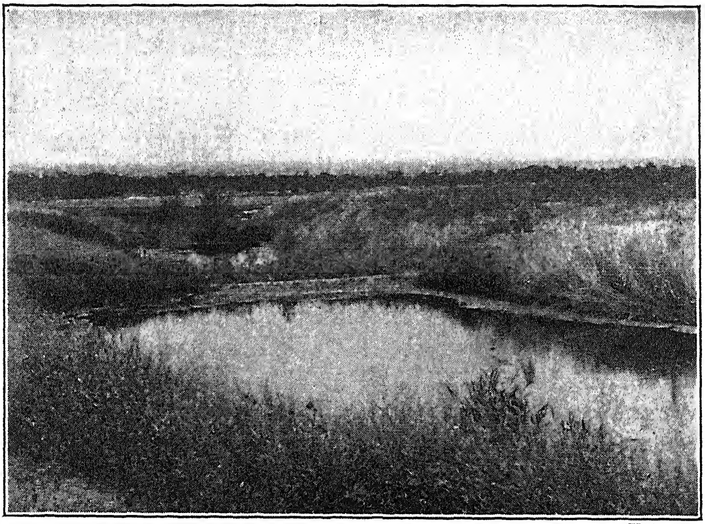
Overgrazing western ranges reduces carrying capacity, exposes soil to wind-erosion losses during drought, and causes water holes to dry rapidly.



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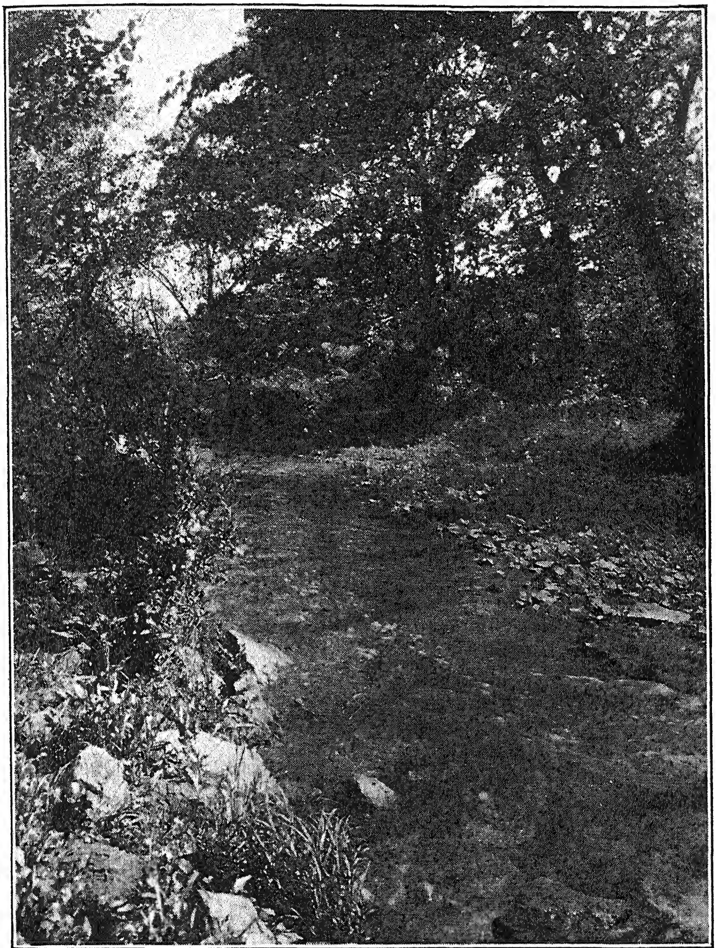
The construction of ponds conserves both water and soil.

Controlled grazing and water conservation are essential practices in the management of western ranges.



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Clear streams flow only through countrysides where soils are protected from severe erosion by grass and woods cover.

controlled grazing, and pond construction may be considered.

Many overgrazed pastures on steep slopes in well-watered regions suffer erosion and may be greatly improved by the plowing of several furrows at intervals of two or more rods, following contours at right angles to the slope, and by liming, fertilizing, and reseeding to increase grass growth.

Grazing should be deferred until grass growth is strong in the spring and should be controlled in accordance with the capacity of the pasture.

In Western areas of deficient moisture, the listing of strips, four furrows or more, 8 or 10 rods apart, with the listed furrows at right angles to prevailing winds, will greatly reduce wind erosion. Planting to adapted grasses and controlled grazing will reestablish sods.

The construction of ponds and reservoirs helps check the run-off of water and will provide needed water to carry over periods of drought.

Our Nation's Future Depends on a Sound Land-Use Policy. Three hundred years of extractive farming have not been without disastrous effects upon our fertility resources. Of the 610,000,000 acres of cultivated land in America, 50,000,000 acres have been ruined by erosion and severe cropping. Another 50,000,000 acres have been seriously injured by extractive cropping, and the stage is set on these acres for early ruination by severe erosion. Nearly one-half of our entire cultivated acreage has been appreciably reduced in power to produce through removal of fertility, overproduction of extractive crops, and erosion by wind and water. The great droughts of 1934 and 1936, the Mississippi flood of 1927, the floods in the eastern half of the United States in 1936, and the record-breaking Ohio and Mississippi floods in the winter of 1937 and the record Mississippi Valley flood of 1947 followed by severe summer and fall droughts that greatly reduced the corn crop and damaged fall-planted wheat have made people as a whole conscious of the way in which the use made of our land and control of our rivers encourage flood and drought.

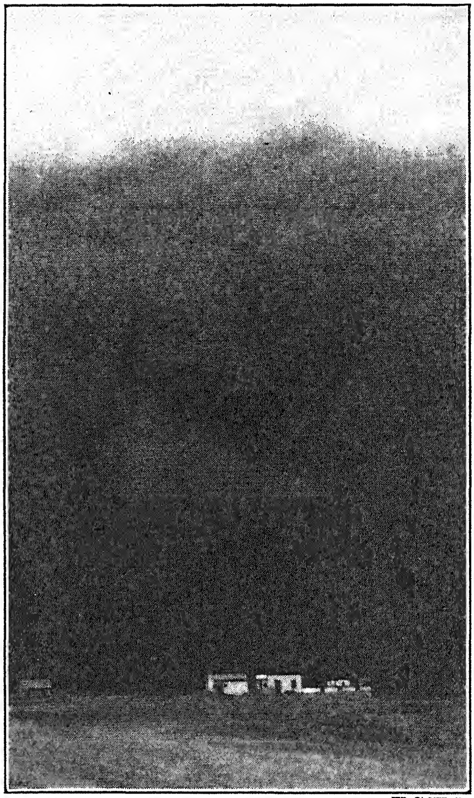
The original cover of trees and grass has been removed from more than two-thirds of the acreage of the eastern or humid half of the United States. In early days, the bottomlands of our great rivers were covered with a dense growth of beech, walnut, hickory, elm, and gum trees. The hillsides and the uplands were covered with great forests of maple, beech, oak, and pine; prairie regions with a cover of vigorous-growing prairie grass. The streams in the eastern part of the United States, even at flood time, ran fairly clear when settlers first became familiar with the country. The run-off of rain and the melting of snow were retarded. The heavily wooded bottomlands, when flooded, served to check the downward flow of water.

Under present conditions, with hillsides denuded of forests and largely cultivated, uplands in farms devoted to too great a proportion of cultivated crops, bottomlands cleared and farmed, and streams narrowed by dikes, floods descend with appalling rapidity, carrying the top soil, developed through the ages, from thousands of acres and causing tremendous property loss and loss of human lives in cities, towns, and on farms in flooded areas. Even greater losses to the nation, but not so apparent, occur far back on the watersheds drained by our major rivers in the loss to our soil fertility of the surface soil carried away by floodwaters.

In 1934, dust storms, originating in the Dakotas, Kansas, Nebraska, and the Panhandle of Oklahoma, Texas, and eastern Colorado, extended far across the continent, darkening the skies of Washington and New York. These dust storms, following long periods of drought, caused tremendous loss through the removal of surface soils and the drifting of soils. We now know that these tremendous losses in the West through wind erosion are the result of putting under the plow great areas of land, once highly profitable when used for grazing.

Our future history as a nation will largely depend upon a national policy in regard to the use of our land. Farmers must receive enough for their crops to pay for the return of the ele-

ments of fertility removed, for applications of lime where needed, and for the maintenance of rotations that carry a suf-



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This appalling cloud of dust advanced on Dodge City, Kansas, April 24, 1935.

ficiently high proportion of soil-conserving and soil-improving crops to prevent excessive loss through erosion and fertility depletion. Areas of land of marginal value, where moisture is deficient, should be returned to native grass, or in humid areas

to grass and forest trees. To state that the solution of the problem is one largely of maintaining humus in the soil, applying fertilizer, and growing grasses, legumes, and trees for cover would be simple, but this program involves the adoption of a program of production control and an economic program assuring farmers adequate returns for their products, and inclusion of crop insurance features and of an ever-normal granary program in the interest of both the farmer and the consumer.

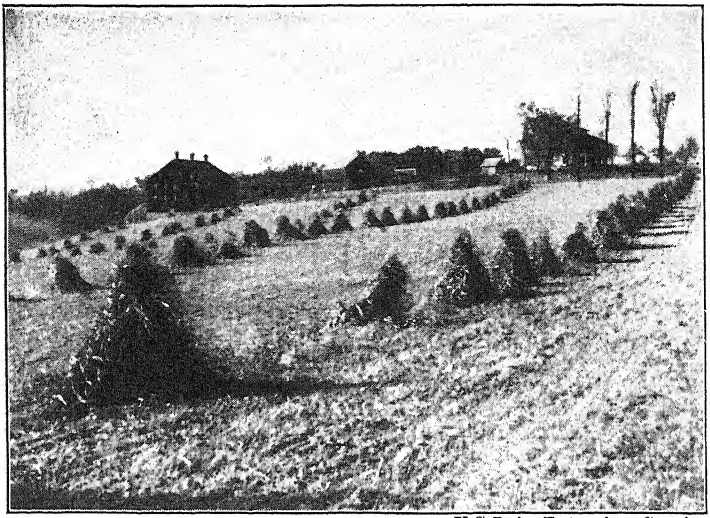
Grass is important in the control of both flood and drought; if we control the raindrop as it falls, damage from floods will be greatly reduced, and moisture, adequate for the maintenance of plant growth through periods of drought, will be stored in our soils.

There are many instances of damage to our magnificent resources through misuse. Before we became a nation, the soils of extensive areas of the original colonies were farmed for over one hundred and fifty years, or for nearly as long a period as our national history. South of our national capital, the John Marshall estate occupied the territory from Marshall Hall, opposite Mount Vernon, to Port Tobacco. For more than one hundred years, virgin lands were cleared and drained, and tobacco and corn were grown by slave labor. Today much of this area is in scrub oak and pines, with only an occasional profitable farm.

In old Colonial Village, Maryland, are the remains of an old customhouse where ocean-going ships once cleared for England. This village is located several miles from the Potomac. At the present time, a rowboat would meet difficulty in coming up the river bed where a once deep stream bed has been silted and closed.

On the other hand, we have examples of fertility maintenance through the employment of good farming practices since early Colonial times. The limestone soils of Lancaster County, Pennsylvania, are a notable example. This county is one of the oldest, agriculturally speaking, in the United States; its history dates back to the early part of the eighteenth century.

After nearly three centuries of farming, Lancaster County still ranks as one of the highest-producing counties in America. A study of farm practices among the Pennsylvania Germans and other farmers who settled this county brings out the facts that, from the earliest time, clover has been grown in rotation



U.S.D.A. Extension Service

Rotating crops, liming, fertilizing, and manuring on the limestone soils of Pennsylvania and Maryland have maintained crop and livestock production at high levels for over two centuries.

with corn, tobacco, potatoes, and grain crops; that the practice of liming is deeply rooted; and that it was a general custom for each generation to assume the obligation of liming the land. In the early days, Lancaster County farmers burned their own lime from limestone quarried on the farm. This practice is still occasionally employed, but has given place largely to the use of ground limestone and other standard forms of agricultural lime. The Lancaster County farmers also use fertilizers high in phosphorus; in fact, they refer to fertilizer as "phos-

phate." In this county also, from the earliest time, the value of manure has been fully realized, and barnyard and stable manures are carefully returned to the land. These practices, liming, manuring, growing legumes in rotation, and applying fertilizer, are considered essential to the maintenance and improvement of the fertility of most of our soils.

Thomas Jefferson, writing about his Virginia farm in 1813, said:

> Our country is hilly and we have been in the habit of plowing in straight rows, whether up or down hill, or however they lead, and our soil was all rapidly running into the rivers. We now plow horizontally, following the curvature of the hills and hollows on dead level, however crooked the lines may be. Every furrow thus acts as a reservoir to receive and retain the waters, all of which go to the benefit of the growing plant instead of running off into the streams.

SUGGESTIONS

1. Secure from the state agricultural college any publications dealing with soil erosion and erosion control within the state.
2. Make an investigation of the soils upon home farms from the standpoint of erosion.
3. Plan specific programs of erosion control for home farms. Determine whether or not such plans can be carried out in cooperation with the local agricultural conservation program.
4. If erosion control is an important problem in your state, erosion control experiment stations have undoubtedly been established. Plan to visit these stations.
5. In most states there is a forestry service of some kind. Become familiar with this service and seek its aid in planning the planting of areas upon home farms to trees of a suitable type.
6. As part of each state government there is usually a conservation department or a commission dealing with wild life or fish and game. Write to these agencies for any available information. It may be practical to cooperate with such organizations in formulating local projects having to do with fish and game.
7. Some schools have been very successful in establishing forest tree nurseries. With a little cooperation such a nursery might be established to provide large numbers of trees for local work in reforestation.

8. Secure a copy of the state law concerning soil conservation districts.

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CHAPTER VII

MANURING, FERTILIZING, AND LIMING FIELD CROPS

. . . As for the farmer who undertakes to take everything from the land without making any restitution, his liberty will eventually be taken from him and he will become the servant of wiser men, either on the farm or elsewhere. C. E. THORNE

Large yields of crops are dependent upon plentiful supplies of plant food in a form which plants can readily use. All the plant foods must be available. A plentiful supply of one element is of little use unless all the other necessary elements are present in proportionate amounts. The grower, of course, need have no concern over the supply of carbon dioxide used in the production of carbohydrates because it comes from a plentiful supply in the air. The water supply, the supply of available plant food in the soil, the physical condition of the soil, and the supply of organic matter, however, are of great concern to the farmer. To starve growing crops is as unprofitable as to skimp in the feeding of livestock.

The factors, operations, and practices involved in manuring, fertilizing, and liming field crops are:

1. Judging the needs for fertilization.
2. Nature's methods of supplying plant food.
3. Supplying plant food.
4. Liming the soil.
5. Making use of additional information.

Judging the Needs for Fertilization. It has been said, "The eye of the master fattens the cattle." It might also be said, "The eye of the master grows bumper crops." The master crop grower watches his crops for signs that indicate trouble in

plant growth. Crops starving for want of sufficient quantities or balance of plant food show certain signs that can be recognized by the person who understands the growth of the plants.

Low yields result when crops are grown without sufficient fertility. Meager or sparse plant growth, slow growth, late maturity, and poor quality of grains and forage often indicate

Alfalfa—Cox and Megee

Properly fertilized pastures furnish the best and cheapest feed for livestock and prevent erosion.

that there is a poor supply of plant food. Some of the conditions described may be due to other causes, but when poor crop growth is obtained it is important to investigate the fertility situation as one possible explanation for the condition.

Some idea of the needs of plants for certain important plant-food elements may be gained by observing what the chemists have found in plants by chemical analysis. Table 3 shows the fertilizing value of feeds derived from various crops.

Soil chemists have learned how to test soils for the presence of certain chemical elements needed by plants. In most states samples of soil may be sent to the state agricultural college for

TABLE 3

FERTILIZING VALUE OF FEEDS

Name of Feed	Fertility in 1000 Pounds		
	Nitrogen (N), pounds	Phosphate (P_2O_5), pounds	Potash (K_2O), pounds
Alfalfa, green	7.7	1.3	5.6
Alfalfa hay	26.1	6.1	17.9
Corn, dent	16.5	7.1	5.7
Cornstalks with ears	7.2	5.4	8.9
Corn stover, no ears	6.1	3.8	10.9
Cottonseed meal	72.5	30.4	15.8
Clover hay, red	19.7	5.5	18.7
Linseed meal (new process)	60.0	17.4	13.4
Timothy hay	9.4	3.3	14.2
Wheat	19.0	5.5	8.7
Wheat bran (winter)	25.1	26.9	15.2

testing. The reports from such tests may be used by farmers as a guide in fertilizing various crops. Certain tests may also be made in the high-school classroom or in the field. By trying recommended practices and watching carefully the results of different programs for fertilizing crops, the efficient farmer will soon discover the best procedures to follow.

In many states, farmers have soil experts visit their farms to take soil samples and note the conditions of crop growth and yields. The soil specialist tests the soil samples and prepares a rather detailed report which the farmer can use as a guide in building the fertility of his farm.

Nature's Methods of Supplying Plant Food. Under natural conditions there is a continuous repetitive process known as a cycle having to do with growth, maturity, death, and decay

followed by growth again. The nitrogen cycle is an example of the process. This cycle is about as follows, beginning with the death of plants and animals:

1. Plants and animals die after living a certain period of time. The plant and animal structures and tissues consist of the various chemical elements derived from soil, water, and air.

2. Decay, decomposition, or putrefaction follows the death of plants and animals. Bacteria and other low forms of life live upon the dead organic matter and bring about the decay of the material. In the process, the carbohydrates, proteins, and fats formed by the plants and animals are reduced to simpler compounds.

3. Nitrogen, which is a part of the complex proteins in plants and animals, is reduced to a rather simple nitrogen compound called ammonia. The odor of ammonia is often found about stables. The presence of such an odor means that compounds containing nitrogen are changing into ammonia compounds. The process is called ammonification. Much nitrogen is often lost from manure in the form of ammonia gas.

4. If conditions are right, the ammonia compounds containing nitrogen are changed by a bacteriological process called nitrification into compounds known as nitrites.

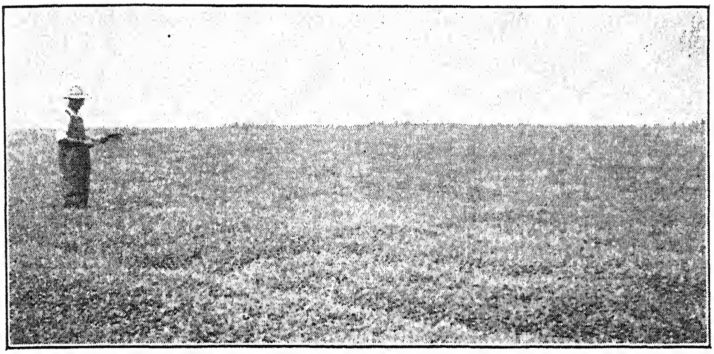
5. The nitrites are changed to nitrates as the next step in the process. Most crop plants take in nitrogen in the form of nitrates. Nitrates are soluble in water and consequently are available to plants through their root systems. If no plants are in the process of growing, available nitrates may be removed in the soil water as it drains away. Therefore it is important to keep the land covered by growing crops in order to save the dissolved plant food from being lost in drainage water.

6. Plants use the plant-food elements, nitrogen in the form of nitrates for example, in their plant growth. They grow to maturity and die, or the plant and its products may be consumed by animals. At the death of plants and animals the process begins again.

Supplying Plant Food. Good farmers are noted for their ability to secure large yields per acre of crops to be marketed or fed to livestock without depleting their soils. Many such farmers follow practices which continually increase the pro-

ductive capacity of the soil on their farms. These results are obtained by following certain principles and practices.

Growing Legume Crops. Such crops as alfalfa, clover, soybeans, peas, beans, vetch, and lespedeza belong to a family of plants called legumes. Legumes are peculiar in that certain bacteria live in nodules on their roots. The bacteria thus housed upon the roots of these plants have the ability to take



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Lespedeza has gained rapidly in acreage in the southern part of the Corn Belt and in the Cotton Belt where adapted. This legume is a valuable soil builder and an excellent pasture and hay crop.

nitrogen from the air in the soil and to fix it in a form which is used by the plant in its growth. By growing legumes and by seeing to it that the legumes are inoculated with the proper bacteria, farmers may be assured of having an excellent supply of nitrogen. Legume plants are noted for their high protein content, and nitrogen is a very important part of protein compounds. By growing legumes, farmers have hay or other feeds of higher quality to feed their livestock, and the manure produced by animals fed in such a manner will have a greater fertilizing value. When leguminous crops are plowed under as green-manure crops, the nitrogen from the air fixed by the bacteria becomes available to the crops that may be planted upon the soil.

Using Barnyard or Stable Manure. The manure from livestock is one of the most valuable sources of plant food. Often manure is handled as if it were a waste product rather than a valuable by-product.

The amount of manure produced per year by farm animals is indicated in Table 4.

TABLE 4

TONNAGE OF MANURE FROM LIVESTOCK OF MIXED AGES ON COMMON RATIONS

Per 1000 Pounds of Animal	Manure plus Bedding, Tons
Sheep	7.5
Steers	8.5
Horse	10.0
Cow	15.0
Hogs	18.0

An average ton of mixed manure contains 10 pounds of nitrogen, 5 pounds of phosphoric acid, and 10 pounds of potash.

The value of manure in dollars and cents can be judged from the following:

A ton of average manure is worth from $2 to $3. This is not a theoretical valuation. It is a field valuation of the actual crop-producing power of manure as measured by crop responses in field tests. Findings in thirty-one manurial experiments in Ohio, involving all field crops grown on thirteen extensive soil types and covering as many as 30 years in some instances, show that one ton of manure produced crop increases worth $2.50. This represents an average of manures of many conditions, ranging from fresh to weathered and aged. Exposed and wasted manures fell $1 under this average.[1]

The Pennsylvania experiment station has found that three to four tons per acre of poultry manure gave results similar to applications of nine to twelve tons of fresh stable manure.

[1] J. A. Slipher, "The Management of Manure in Barn and Field," *Ohio State University Agricultural College, Extension Service, Bul.* 131.

Manure should be carefully preserved because unwasted manure is the most valuable. If manure is allowed to ferment or heat, a large amount of nitrogen in the form of ammonia escapes into the air. Manure scattered over barn lots where the rain falls upon it loses much of its value in the water which drains away. Several procedures may be considered as means of securing the greatest value from manure.

A. *Haul promptly to the field.* Whenever possible, manure should be spread upon the land as fast as it is produced. The rapid drying prevents fermentation and loss of nitrogen. When rain comes, the leachings from the manure drain into the soil. To a large extent the soil will hold the plant food thus received until it is taken from the soil by growing plants.

B. *Provide plenty of bedding or litter to soak up liquid manure.* Cut straw or shredded cornstalks make excellent material to use in absorbing the liquid portions of manure. Whole straw is very good for the purpose but whole cornstalks are poor. In some sections peat moss may be used with great satisfaction.

C. *Add preservative to prevent manure from losing plant-food elements.* It has been found that the addition of about thirty pounds of superphosphate per ton of manure as it is produced greatly reduces the loss of nitrogen in the form of ammonia gas. The phosphate may be scattered in the gutters of the stables either before or after cleaning.

In addition to preserving the manure, the superphosphate is a valuable fertilizer in itself and tends to supplement the manure. Manure is rather low in phosphorus content; consequently the addition of phosphate makes manure a better-balanced fertilizer. Table 5 indicates the value of superphosphate as a preservative.

The tendency of some soils to fix phosphate and to make it unavailable to plants can be corrected to a satisfactory degree by using manure and phosphate mixed because the manure absorbs the phosphate and keeps it in a form available to plants.

TABLE 5

PRESERVATIVES ADDED TO MANURE HOLD AMMONIA GAS *
(Ammonia gas contains nitrogen.)

Preservative	Ammonia Escaped in Four Months, Per Cent
None	56
Rock phosphate	45
Straw	19
Superphosphate	3

* J. A. Slipher, "The Management of Manure in Barn and Field," *Ohio State University Agricultural College Extension Service, Bul.* 131.

D. *Store manure carefully.* If manure cannot be hauled to the field as it is produced, certain steps should be taken to store it properly. If possible, manure should be stored under cover to prevent rain from washing it. There should be a tight floor under the manure to prevent the liquid portions of the manure from draining away. It should be stored in such a manner that the tramping of livestock will pack it tight. The packing of the manure prevents the entrance of air and thus reduces fermentation.

E. *Apply manure efficiently.* A common practice is to put manure upon land which is to be plowed for such intertilled crops as corn, potatoes, tobacco, and various truck crops. There is evidence to show that it pays to put the manure on the land well ahead of the time it is to be used by the crop, so far as corn and wheat are concerned at least. From Table 6 it may be concluded that manure should be applied during the summer of the season previous to that in which the crop is to be grown, although the time of application depends upon the type of soil and other factors.

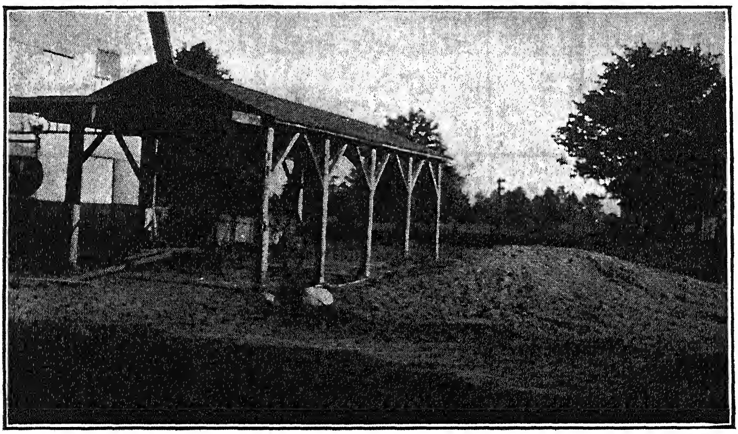
It is safe to put manure on soil types ranging from clay to silt during the fall and winter because these soils will retain the material washed into them from the manure. On light sandy soils the manure should be put on only a short time before the land is plowed. Such soils do not hold plant food

TABLE 6

APPLYING MANURE AT DIFFERENT SEASONS *

	Fresh Manure		Rotted Manure	
	Corn, bushels	Wheat, bushels	Corn, bushels	Wheat, bushels
Summer—July	82.8	20.0	71.8	22.0
Fall—November	69.1	18.4	68.0	17.3
Winter—January	58.2	17.9	....	....
Spring—March	57.5	17.8	61.4	18.0

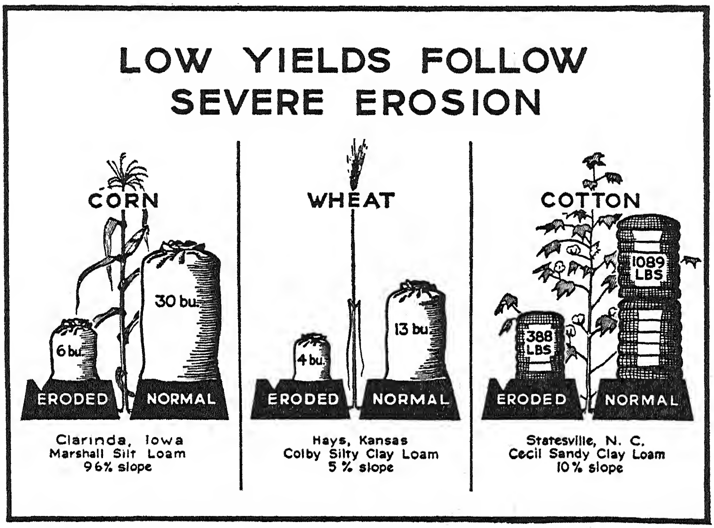
* W. T. L. Taliaferro and H. J. Patterson, "Stable Manures," *Maryland Agricultural Experiment Station, Bul.* 122.



The manure spreader under shed is filled as manure is produced in dairy barn at left. Spreading manure as produced reduces fertility losses.

well, and, if the manure is applied early, much of its value will be lost.

In regions where wheat follows corn in rotation, it is advisable, if there is a good supply, to put some manure on the wheat instead of putting all of it on the corn crop. For



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Low yields of corn result where topsoil is removed by erosion.

winter wheat it is a good practice to top-dress with manure at the rate of 4 or 5 tons per acre.

It is also advisable to top-dress pasture lands. New seedlings of legumes may be profitably top-dressed after the companion or nurse crop has been removed. Such top-dressing helps the new seedlings to become well established before winter.

In summing up the benefits of using manure on the soil it may be said that manure:

Improves the tilth of the soil, thereby making it easier to handle.

Increases the water-holding capacity of the soil, thus increasing the drought resistance of a soil.

Adds plant food at the rate, for an average ton of manure, of 10 pounds of nitrogen, 5 pounds of phosphorus, and 10 pounds of potassium.

U.S.D.A.

Plowing under crimson clover and grain stubble. Crimson clover is an important green-manure crop in the truck-crop regions of the Eastern Coastal Plains and in many states south of the Ohio River.

Hastens the decaying processes in the soil because manure contains many of the organisms which under proper conditions cause the rapid decay of plant and animal material.

Artificial Manure. Soil organic matter or soil humus is often difficult to maintain under cropping conditions when barnyard manure is unavailable. The New Jersey Experiment Station has found that artificial manure of good quality, useful in restoring soil organic matter, may be made from cornstalks in about three months and from grain straw in four to six months by adding inorganic or chemical fertilizers to these types of plant materials. Other plant materials may be made into artificial manure in the same manner.

Cover-Cropping and Green-Manuring. Farmers are becoming more and more convinced that it is profitable to grow certain crops during particular periods of time just to keep the land from being bare or without cover. When a soil is well covered by a growing crop there is little chance for soil to wash or blow away and for plant food to be leached out in the drainage water. Cover crops should be planted whenever possible if the soil has a tendency to erode, that is, to wash or blow away. Where winter wheat is grown in the Corn Belt, the wheat acts as a cover crop during the fall and winter. Many cover crops are grown chiefly for the purpose of keeping the soil covered, and when their period of usefulness is over they are plowed under.

In many regions it is good farm practice to grow certain crops to be plowed under as manure to improve the soil for a succeeding crop. Crops grown for this purpose are called green-manuring crops. Often it is possible to raise cover crops which also are plowed under as green-manuring crops.

Crops belonging to the legume family are especially useful as cover and green-manuring crops because, if properly inoculated, they tend to increase the supply of nitrogen in the soil. If the land is not suitable for the production of legume crops other crops adapted to the soil conditions may be planted.

By using a good cover-cropping and green-manuring system it is possible to keep soil in good condition. Even in livestock regions where much manure is available it is advisable to use cover crops and green manures, although they are not quite so necessary. In the northern Corn Belt many cornfield soils left exposed during the winter months should be covered with some crops sown at the time of the last cultivation.

Using commercial fertilizers. The benefits of using an adequate supply of fertilizer are well illustrated by Table 7.

Commercial fertilizers are usually described by trade names or by the chemical analysis of the available plant-food elements which they contain. A 2–12–6 fertilizer refers to a fer-

TABLE 7

FERTILIZERS SPEED GROWTH, INCREASE QUALITY, AND INCREASE YIELD OF CORN *

(Results of Fertility Treatment on Burr Leaming Corn at Wooster, Ohio.)

Treatment per Acre	Planted May 13				Planted June 3			
	Days planting to silking	Moisture at husking, %	Nubbin, %	Yield, 15.5 % moisture	Days planting to silking	Moisture at husking, %	Nubbin, %	Yield, 15.5 % moisture
None	117	48.3	71	17.7	110	69.1	76	5.5
Manure, 8 tons, 225 lb., 16% superphosphate broadcast	104	46.7	38	45.2	97	53.4	55	31.9
Same plus 100 lb. 3–12–4 in hill	99	37.9	37	55.9	93	50.7	42	33.3
Same plus 200 lb. 3–12–4 in hill	93	33.5	21	70.3	88	50.0	18	47.9
Same plus 400 lb. 3–12–4 in hill	90	31.4	12	80.6	86	46.0	19	56.9

* *Ohio Agricultural Experiment Station, Bi-monthly Bul.* 132.

tilizer containing 2 per cent nitrogen, 12 per cent phosphoric acid, and 6 per cent water-soluble potash. In some states the order in which the materials are given is different.

The common carriers of nitrogen, phosphoric acid, and potash, or in other words the materials which are used in preparing fertilizers, are described in Table 8.

Various amounts of such carriers as described in Table 8 are combined with enough filler to make a hundred pounds or a ton, as the case may be, of fertilizer containing a given amount of nitrogen, phosphoric acid, and potash.

The amounts of commercial fertilizer to be used in a given situation depend upon a large number of factors. In every state where commercial fertilizers are useful in growing crops there are available, from the state experiment station or agricultural extension service, bulletins which give recommenda-

TABLE 8

PROPERTIES OF COMMON FERTILIZER INGREDIENTS *

Material	Composition, Per Cent			Degree of Availability	Source	Remarks
	Nitrogen	Available phosphoric acid	Potash			
Nitrate of soda	15.5–16	......	......	High	Chile and synthetic	
Sulfate of ammonia	20–21	......	......	High	By-product of coke ovens and synthetic	Leaves acid residue corrected by equal weight of limestone.
Cyanamid	22	......	......	High	Synthetic	About equal to limestone in neutralizing power.
Urea	46	......	......	High	Synthetic	
Animal tankage	4–8	3–8	......	Medium	Packing houses	Used as conditioner.
Tobacco stems	1.5–3.5	trace	5–10	Medium	Tobacco residues	Used as conditioner.
Garbage tankage	2.5–3.5	trace	trace	Very low	Garbage reduction plants	Used as conditioner; availability may be increased by acid treatment.

Superphosphate	....	16–46	......	High	Rock phosphate treated with sulfuric acid	Most common source of phosphoric acid in mixed fertilizer.
Steamed bone meal	1.5	23–26 (total)	......	High	Packing house	Little used in mixed fertilizers.
Basic slag	....	8–18	......	High	Smelting of phosphatic iron ores	Lime equivalent to 80 per cent carbonate of lime.
Raw rock phosphate	....	25–30 (total)	......	Low	Mined in Tennessee, Florida, and elsewhere	Not used in mixed fertilizers.
Muriate of potash:						
Foreign	....	......	50	High	Germany and France	Principal source in mixed fertilizers.
Domestic	....	......	60	High	California and New Mexico	
Sulfate of potash	....	......	48	High	Germany and France	Used in tobacco fertilizers.
Kainit	....	......	12–16	High	Germany and France	
Manure salts	....	......	20–40	High	Germany and France	
Ammo Phos	16	20	......	High	Nitrogen synthetic	Effect on soil reaction similar to that of ammonium sulfate.
	11	48	......	High		
Nitrophoska	15	30	15	High	Nitrogen synthetic	

* Robert M. Salter and Earl Jones, "Fertilizing Field Crops in Ohio," *Ohio State University Agricultural College Extension Service, Bul.* 136.

tions for the use of certain standard-ratio fertilizers. By following such recommendations, observing the results carefully, and making the necessary adjustments to meet certain specific situations, farmers can soon arrive at the most profitable practices to follow in the use of commercial fertilizers.

A number of experiment stations have observed that in certain areas small applications of such elements as boron, magnesium, manganese, zinc, and copper result in increased yields and improved qualities in plant products. The Vermont station, for example, has demonstrated that small amounts of boron increased the production and quality of such crops as alfalfa, potatoes, clover, and sweet corn. This station found that 40 pounds of borax gave three more tons of alfalfa hay during a three-year period. It is very important to follow experiment station results in using such elements as fertilizer because damage may occur if large amounts are used.

In deciding upon the kind and amount of fertilizers to use the following factors must be considered.

A. *The crop for which the fertilizer is intended.* Different crops call for different amounts and combinations of nitrogen, phosphorus, and potassium. For this reason it is necessary to know the crop for which the fertilizer is intended.

B. *Color of the soil.* Information will be needed about the color of the soil. Dark-colored soils contain more organic matter in the form of humus and, for this reason, more plant food is already present in the soil, especially nitrogen. Dark-colored soils usually need smaller amounts of complete fertilizers, and often the amount of nitrogen, in comparison to that needed for a light-colored soil of the same general type and condition, may be reduced.

C. *Type of soil.* The amount of fertilizer needed will also depend upon whether the soil is a sandy type, a silt loam, a clay loam or a clay, or is classified as a muck or peat. These types of soil vary in the amounts of plant food they

contain and require the application of different amounts of fertilizers.

D. *Treatment of soil previous to crop for which fertilizer is needed.* The amount and combination of commercial fertilizers needed will depend upon how much manure is available. Before he decides what commercial fertilizer to buy, the farmer should obtain information about the amount of manure used for the previous crop or intended for the immediate crop.

It is important also to know whether or not a full crop of clover or other legume, green or mature, was plowed under for the immediate crop.

As previously mentioned, most states in which commercial fertilizers are needed have publications for use as guides in determining the amount of fertilizer to use, depending upon such conditions as have been enumerated.

In general it is better to buy and use high-analysis fertilizers, provided the fertilizer attachments on the machines owned by the farmer will distribute properly the smaller amounts of materials. It will usually be found that high-analysis fertilizers are cheaper per pound of available plant food than low-analysis fertilizers. The cost of handling high-analysis fertilizers is less because smaller amounts need be purchased.

Applying Fertilizers. Fertilizers may be applied in the hill, in the row, broadcast, or as a top-dressing. The various methods depend upon the crop being grown. With certain row or hill crops it is common practice, after the crop is well started, to side-dress with certain quickly available fertilizers.

The placing of the fertilizer should be made with care in order not to injure the growing plants and also to insure the use of the fertilizer by the plant. As a result of various investigations certain principles of fertilizer placement have been established.

Best results are obtained when the fertilizer is placed as close to the seed as possible without injury to the seed or seed-

ling. When fertilizers are placed above or below the seed or in contact with it they are likely to cause damage. If fertilizer is placed at the side of the seed, one inch or more away, there is very little danger of damage.

Manufacturers of fertilizer-distributing attachments have produced machinery which will deposit a band of fertilizer on either side of the seed or seed piece, in the case of corn and potatoes.

Liming the Soil. Calcium carbonate, or lime as it is commonly called, is very soluble and easily leached from surface soils under cultivation. Most soils, even those of limestone origin which have been in use for five generations or more, are benefited by the proper use of lime. Large areas of our soils, particularly sandy soils and light loams in the Northern States, are naturally deficient in lime. Sorrel, sedge, and dock seem to thrive on acid soils; clovers and leguminous plants, in general, make poor growth under acid conditions.

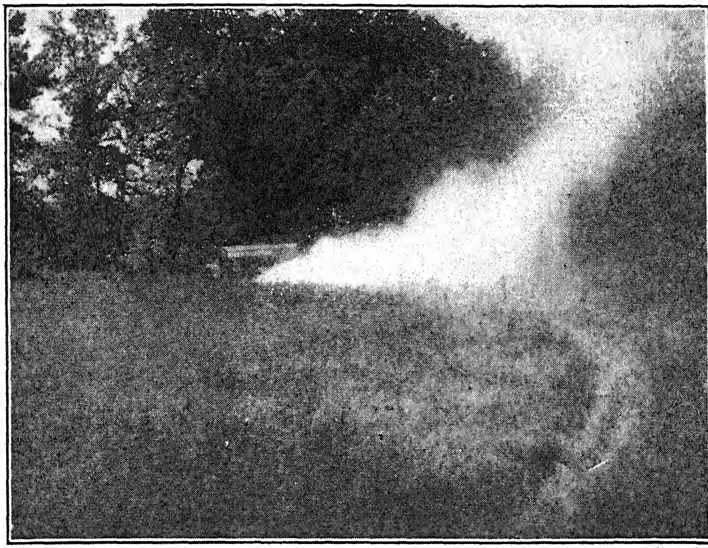
It is necessary to apply lime in proper amounts to acid soils in order to succeed with alfalfa, clover, and sweet clover; hence the liming of land to a proper degree is essential in preparing such soils for rotations carrying these crops. As a general rule, 2 tons of finely ground limestone per acre will fit the large majority of acid soils for alfalfa and clover growing. If marl is available, 3 or 4 cubic yards is usually sufficient per acre. Throughout the northern Lake States, marl can often be found under conditions where it can be handled economically.

Hydrated lime is a convenient form where the area to be limed is located a long way from a railroad station or shipping center. From 1500 to 2500 pounds per acre is generally needed.

Lime should be applied, if possible, when the seed bed is being prepared for a cultivated crop, though it may be applied at the time of seeding the clover crop. If applied the year before, its action on the clover is much more certain. It is

usually necessary to repeat the liming every eight to twelve years.

Soils should be carefully tested for lime requirement. Such tests as Teskit, Richorpoor, Soiltex, or Truog may be used to advantage. In every state in which it is necessary to lime



U.S.D.A. Extension Service

Lime is now generally applied to fields from the truck that delivers the lime to the farm.

certain soils the state agricultural college has bulletins giving directions for testing the lime requirements of soils and for applying lime.

It is difficult properly to develop dairy and livestock feeding in the Northern States without the use of alfalfa, clover, ladino, and sweet clover. These crops are lime-loving plants and are unusually high in their content of calcium carbonate, as compared with non-leguminous hay and forage plants. A heavy draft is made on calcium carbonate in the proper devel-

opment of animal bone and in milk production; hence the application of lime is a basic practice in crop production and in livestock feeding in regions where lime is needed. Although clovers, alfalfa, and leguminous crops in general are more exacting than most other crops in their lime requirements, proper applications of lime greatly benefit practically all crops in the ordinary farm rotations. The benefits are due to the direct effect of the lime and to an increase in the content of organic matter as a result of more vigorous leguminous crops.

Experiments at many experiment stations show that commercial fertilizers, phosphate fertilizers in particular, are much more effective on land well supplied with lime.

In Table 9 figures taken from printed materials show the value of using lime upon a soil where it is needed.

TABLE 9

YIELDS AND VALUE OF CROPS GROWN ON LIMED AND UNLIMED SOIL, 1917–1931 *

	Unlimed	Limed
Corn	23.1 bu.	45.8 bu.
Oats	36.0 bu.	49.0 bu.
Wheat	17.7 bu.	27.9 bu.
First-year hay (clover and timothy)	1228 lb.	3405 lb.
Second-year hay (clover and timothy)	1496 lb.	3684 lb.
Total value of crops per rotation	$58.39	$108.57
Gain for liming per rotation	......	50.18
Cost of lime per rotation	......	6.50
Balance per rotation	......	43.68

* Earl Jones, "Liming Ohio Soils," *Ohio State University Agricultural Extension Service, Bul.* 177.

Additional Information

The experiments of our oldest agricultural experiment stations show clearly how rapidly our best soils are depleted in lime content. On the famous soil-fertility plats of the Pennsylvania State College, begun in 1882, even though limestone underlies the soil a few feet

below the surface, all the plats, except where lime has been applied, are acid, and crop yields are much reduced. In the Ohio Experiment Station rotation experiments, begun in 1894, one lime application every five years almost doubled the production of the crops grown in rotation where both limed and unlimed plats were fertilized. On the basis of the extensive experiments with lime in Illi-

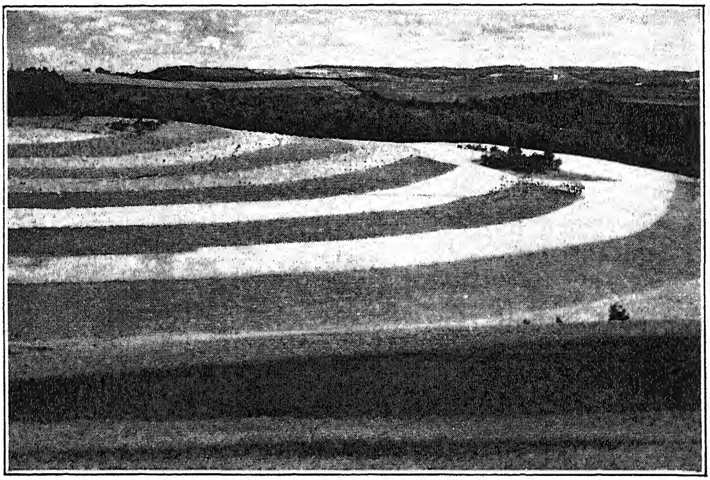
A.A.A., U.S.D.A.

Soybeans planted broadcast for green-manuring purposes.

nois, Dr. F. C. Bauer states that lime renewals will always need the attention of Illinois farmers, and limestone must remain the key to any successful soil-building program on lime-deficient soils.

One of the most remarkable scientific contributions in recent years is the inventory of soil-fertility resources by Dr. Jacob G. Lippman and his associates, presented in Bulletin 607 of the New Jersey Experiment Station of June, 1936. This report indicates that lime is being depleted from our surface 6⅔ inches of soil at a rapid rate. Dr. Lippman estimates a net annual loss of calcium of 55,624,057 tons and of magnesium of 20,517,068. Our normal application of agricultural lime is about 3,000,000 tons. Of course, there would be

sub-soil renewals, but sub-soil farming is not an attractive prospect. Dr. R. M. Salter, of the Ohio Experiment Station, estimates that if the present rate of loss of fertility continues unabated the soils of Ohio will possess fifty years hence a productive capacity only three-fourths as large as at present. He recommends that the annual usage of lime be increased to at least five times the maximum yet



U.S.D.A. Soil Conservation Service

A fine example of conservation farming in Steuben County, New York.

applied. ("Our Heritage—The Soil," *Bulletin* 175, *Ohio Extension Service.*)

If American farmers will apply sufficient agricultural limestone and fertilizers there will be no real danger that our soils will be wholly depleted in lime and fertility in 150 or 200 years. The matter of liming and fertilizing as essential practices must from now on be included in our farming methods, and the prices that farmers receive for their crops must be sufficient to include the cost of applying lime and fertilizer, and of rotating crops, in the interest of both the farmers and the nation.

In Kentucky's famous limestone country, the Bluegrass Region, the high mettle, endurance, and speed of Kentucky horses are attributed to the grass and water of the limestone soil. As the use

of lime increases, the mineral and vitamin content of our grains, vegetables, meat, and milk increases also. There will be less rickets and malnutrition in children, and folks will be healthier, happier, and longer lived.

The Production Marketing Administration and the Soil Conservation Service cooperate with farmers in providing lime and phosphate

U.S.D.A.

Diversified farming, with increased acreages of meadows and pastures, and with established farm woodlots, encourages wild life. Hunting desirable game birds is a source of pleasure and profit.

and in encouraging soil-conservation practices, farm woodlot and windbreak plantings, establishment of stock water and fish ponds, and many other practices that contribute to a better-balanced, more permanent, and more profitable agriculture.

SUGGESTIONS

1. Secure from your state agricultural college and experiment station and from the United States Department of Agriculture the bulletins dealing with manuring, fertilizing, and liming crops.

2. Have samples of soils tested at the state agricultural college. When suitable tests are available make tests in the high-school classroom or

in the field. Directions for making such tests may usually be found in bulletins issued from the state agricultural college.

3. From surveys already made, or by making surveys, assemble information about the practices having to do with manuring, fertilizing, and liming field crops that farmers are following. If a certain farmer is particularly successful in maintaining the fertility of his soil, make a trip to the farm to study his plan.

4. Arrange to visit your state experiment station on a day when the field-crop experiments are being explained. This probably will come at a time of year when school is not in session, but it is well to make plans for such a trip while school is still in session.

5. Plan to visit a quarry where agricultural limestone is prepared for the use of farmers.

6. Secure from dealers in fertilizer samples of their products, tags, prices, and other descriptive information.

7. One of the best methods to use in learning to understand and manage farm-problem situations is to make detailed plans in such a form that they may actually be put into operation. Whether projects, supervised practice work, or other farming programs on home farms are involved, the objective should be to plan and execute the practices and procedures which will solve the problems involved. The following suggestions may be of use in directing the procedure.

a. Are more legumes needed in the cropping program? Plan ways and means of increasing the acreage of legumes if needed.

b. Examine the method of handling barnyard manure for possible improvements.

c. Determine the lime requirements of soils for growing the needed crops. Make specific plans for liming the soil when needed.

d. Make detailed plans for securing the right kind and amount of fertilizers for the specific crops that are to be grown. Plans may be made for making tests of various fertilizer treatments on pastures, meadows, and cultivated crops. Such tests may often be made in cooperation with experiment station or agricultural extension forces. State bulletins will be found useful in deciding on fertilizer practices to be tried in a local community.

The planning suggested in No. 7 above may be done in connection with the work proposed in Chapter XVIII.

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CHAPTER VIII

GROWING BEST-ADAPTED CROPS

It isn't enough simply to grow crops, but they must be so produced as to yield a profit on the capital invested. ALFRED VIVIAN

Success in farming is largely determined by the judgment of the individual farmer in the choice of crops best adapted to his climate, soil conditions, and marketing possibilities, with consideration, also, of his own personal liking. On a majority of farms livestock and poultry must be included in the program of farm management if roughage and grain are to be produced efficiently, fertility maintained, and labor and equipment used to best advantage. In the choice of livestock and poultry, adaptation to climatic and soil conditions and local market demands are important factors to be determined. If he selects crops well adapted to climate and soil, for the marketing of which local facilities are available, the farmer will be able to produce these crops most dependably and at lowest cost per acre. The area of the farm that must be devoted to permanent pasture and to legumes to prevent erosion and to build up fertility will depend largely on the topography of the land and on the type of soil. The proportion of beef cattle, dairy cattle, hogs, sheep, horses, and poultry that must be maintained in association with the adopted cropping system will depend largely on the proportion of pasture, hay, and grain feeds produced.

The farmer who chooses crops not particularly adapted to soil and climate or to his available marketing facilities produces under a handicap. Often it is possible to produce only one-half or two-thirds of the yield secured by farmers located more favorably for the production of these crops. Careful

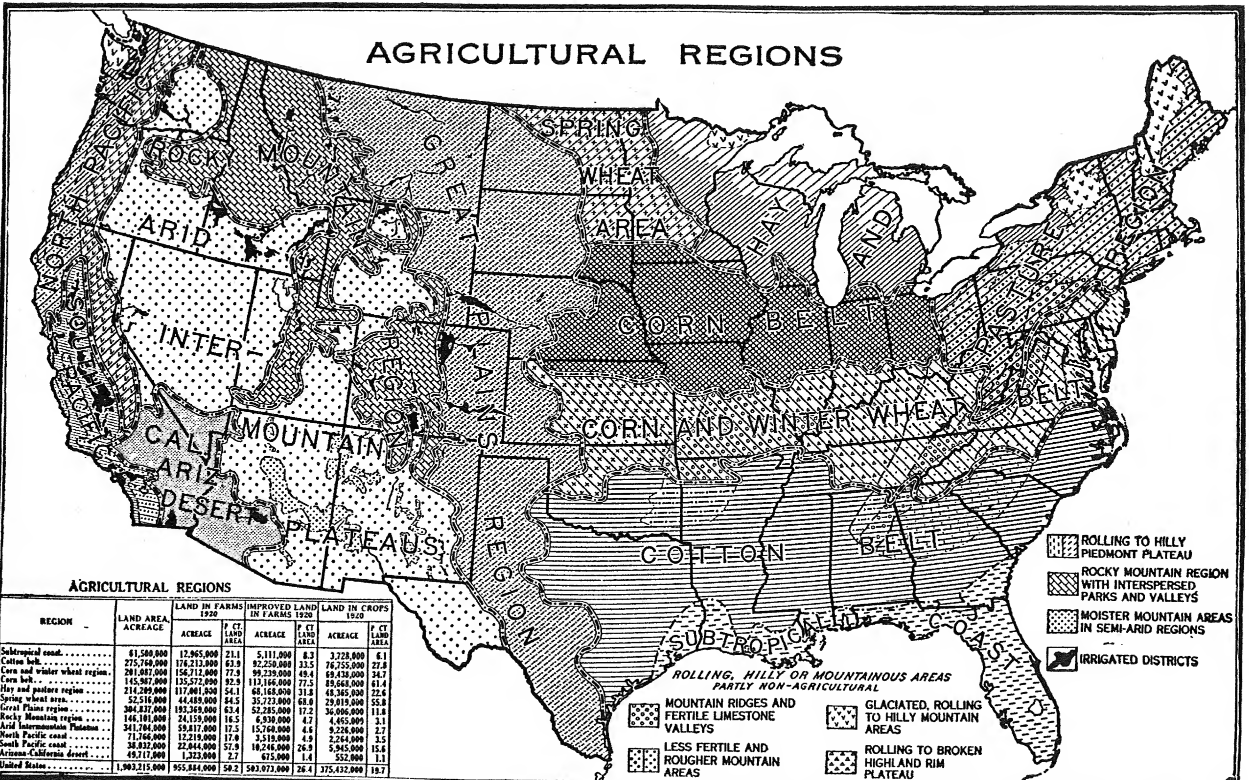
judgment must be used in the choice of crops which will find a profitable market.

The operations involved in growing adapted crops successfully are:

1. Choose crops adapted to your season.
2. Consider temperature, precipitation, and sunlight in relation to crop production.
3. Investigate the climatic adaptations of crops.
4. Grow the crops that are best adapted to your soil conditions and are most effective in maintaining fertility.
5. Grow the crops that can be marketed most effectively either directly or as feed for livestock.

Choose Crops Adapted to Your Region. From the standpoint of climate alone, even if soil adaptation is not considered, great variations occur in crop adaptations. The continental territory of the United States produces in the extreme southern areas of Florida, southernmost Texas, and southern California crops adapted to tropical and semi-tropical conditions. Under these conditions the growing season extends throughout the year, and in the southern extremes of Florida and Texas the rainfall averages over 60 inches and frost is unknown or exceedingly rare. In the southern regions of California, where the rainfall is deficient, irrigation is employed. In these regions, in addition to oranges, grapefruit, and other citrus fruits, the leading crops are winter and summer truck crops, forage, and soil-improving crops particularly adapted to these regions.

The Cotton Belt. The Cotton Belt, which includes primarily the Gulf States, the Carolinas, Tennessee, Arkansas, parts of Oklahoma and Missouri, offers a growing season of two hundred days or more. The mean or average summer temperature is not below 77 degrees, and the rainfall varies from 50 inches or more in the eastern and southern parts of this region to 20 inches in parts of the cotton-growing territory of Texas and Oklahoma. Among the crops adapted to certain



AGRICULTURAL REGIONS

REGION	LAND AREA, ACREAGE	LAND IN FARMS 1920		IMPROVED LAND IN FARMS 1920		LAND IN CROPS 1920	
		ACREAGE	P. CT. LAND AREA	ACREAGE	P. CT. LAND AREA	ACREAGE	P. CT. LAND AREA
Subtropical coast	61,500,000	12,965,000	21.1	5,111,000	8.3	3,728,000	6.1
Cotton belt	275,760,000	176,213,000	63.9	92,250,000	33.5	76,755,000	27.8
Corn and winter wheat region	201,087,000	156,712,000	77.9	99,239,000	49.4	69,438,000	34.7
Corn belt	145,987,000	135,572,000	92.9	113,166,000	77.5	89,668,000	61.4
Hay and pasture region	214,209,000	117,001,000	54.1	68,168,000	31.8	48,365,000	22.6
Spring wheat area	52,516,000	44,489,000	84.5	35,723,000	68.0	29,019,000	55.8
Great Plains region	304,837,000	193,369,000	63.4	52,285,000	17.2	36,006,000	11.8
Rocky Mountain region	146,101,000	24,159,000	16.5	6,930,000	4.7	4,465,000	3.1
Arid Intermountain Plateaus	341,704,000	59,817,000	17.5	15,760,000	4.6	9,226,000	2.7
North Pacific coast	71,766,000	12,219,000	17.0	3,519,000	4.9	2,264,000	3.5
South Pacific coast	38,032,000	22,044,000	57.9	10,246,000	26.9	5,945,000	15.6
Arizona-California desert	49,717,000	1,323,000	2.7	675,000	1.4	552,000	1.1
United States	1,903,215,000	955,884,000	50.2	503,073,000	26.4	375,432,000	19.7

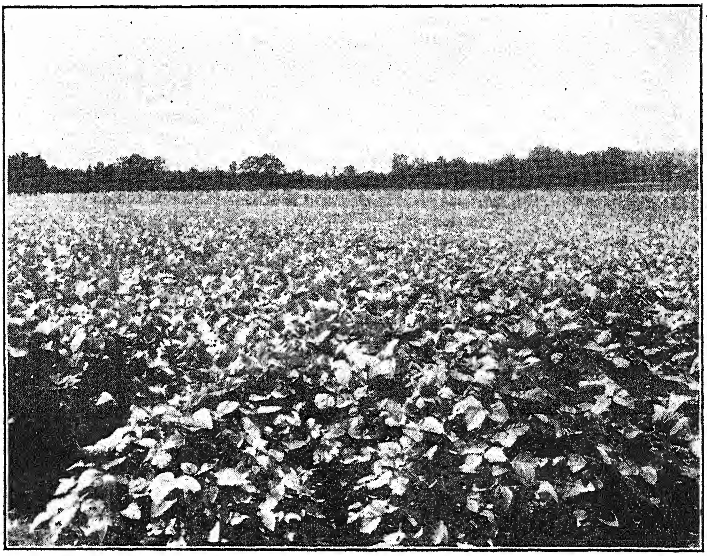
B.A.E., U.S.D.A.

areas of this region are cotton and corn over most of the area, tobacco in the Carolinas, Virginia, and Tennessee, sugar cane in Mississippi and Florida, rice in Arkansas, and cowpeas, velvet beans, soybeans, and lespedeza in most of the region. Peanuts are an important crop in the eastern and central cotton states. Sorghum and sudan grass are adapted to the western cotton region. Winter oats and winter rye are important cover and forage crops throughout this region, and winter barley and winter wheat are grown in the northern part. Other crops that give cover and provide growth during the winter are winter peas and hairy vetch. Major grasses are dallis, bermuda, and carpet grass; the legumes, such as alfalfa and the clovers, are less important than in the North. Such important soil-building legumes as kudzu, crotolaria, lespedeza, velvet beans, cowpeas, winter vetch, and winter peas are increasingly important.

The Corn and Winter Wheat Belt. The corn and winter wheat belt includes the eastern half of Kansas, lower parts of Missouri, Illinois, Indiana, Ohio, all of Kentucky, nearly all of Tennessee, Virginia, West Virginia, and Maryland. In this region corn and winter wheat are primary crops in rotation. Red and alsike clover, alfalfa, lespedeza, soybeans, and cowpeas are the principal legumes, and bluegrass, redtop, timothy, and orchard grass are among the leading grasses. In Kentucky, Virginia, and Maryland tobacco is an important cash crop. Peanuts are important in Virginia.

The Corn Belt. The Corn Belt is the heart of the nation's agricultural region. It includes Iowa, the northern two-thirds of Illinois, Indiana, the eastern half of Ohio, the northern half of Missouri, the western half of Nebraska, and small adjacent areas in Kansas, South Dakota, Minnesota, Wisconsin, and Michigan. This regions offers 140 to 160 growing days. The mean summer temperature is 70 to 80 degrees, and there is an annual rainfall of 25 to 40 inches. The fact that, as a rule, the rainfall of the Corn Belt is evenly distributed throughout the summer growing season is important for effi-

cient production of corn. Corn, winter wheat, oats, and spring barley are the major grain crops of this region. Soybeans have become exceedingly important during recent years. Sweet corn and tomatoes are important canning and truck crops. Near large centers of population potatoes are grown



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Soybeans have become a major crop of the Corn Belt.

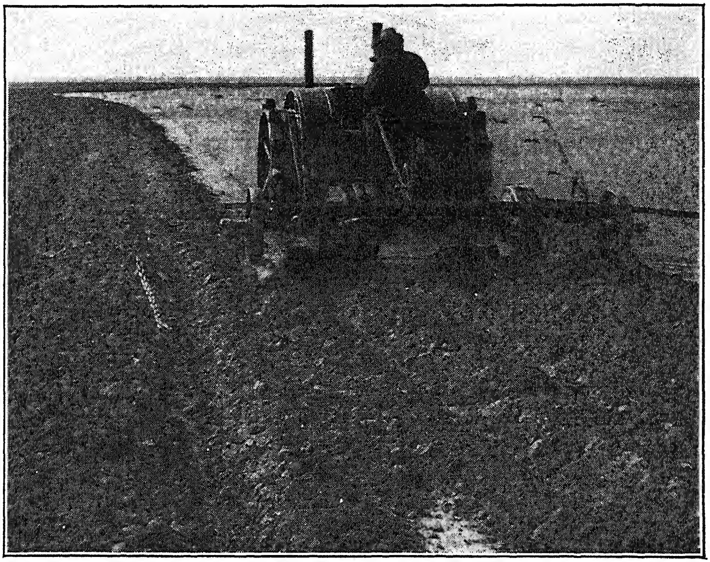
extensively. Kentucky bluegrass is the important pasture grass; timothy, redtop, and orchard grass are important hay grasses. Alfalfa, red clover, and sweet clover are the leading leguminous hay and pasture crops. This region is one of the most productive agricultural regions of the world, from the standpoint of crops produced for market and of the production of hogs, beef cattle, dairy cattle, and poultry.

The Hay and Pasture Region. The hay and pasture region includes the eastern part of Minnesota, nearly all of Wisconsin, Michigan, eastern Ohio, West Virginia, Pennsylvania,

New York, and the New England States. The growing season is comparatively short, the rainfall is ample, and snow protection is offered during the long winter. Bluegrass, both Kentucky and Canadian, timothy, redtop, orchard grass, and meadow fescue are the leading hay and pasture grasses. Alsike, red clover, alfalfa, and sweet clover are the important hay and pasture legumes. Pasture and hay crops of this region are productive and dependable, and hence dairying and the production of sheep, hogs, and other livestock are important. The leading grain crops are corn, for grain and ensilage, wheat, winter wheat, oats, barley, and rye. Potatoes are a major crop in the Lake States, Pennsylvania, New York, Maine, and other New England States. Sugar beets are extensively produced in Michigan and Wisconsin; beans and field-beans in Michigan and New York. The region is an important truck and canning area; it produced cabbages, onions, tomatoes, sweet corn, peas, and beans. The production of seed, garden, and truck crops is highly developed and is a special industry in Michigan, New York, and Wisconsin. The highly diversified agriculture of the region maintains the intensified populations of the leading manufacturing centers of the nation.

The Spring Wheat Area. The spring wheat area occupies western Minnesota, eastern North Dakota, and northeastern South Dakota. In this area hard spring wheat of the highest milling quality is the cash crop. Oats and barley are important. Corn is important in the southern part of the region and except for silage is less important in the northern part. The sunflower is a valuable silage crop in the northern part of this region. Potatoes and root crops thrive, and alfalfa, sweet clover, red clover, and alsike are the leading legumes. Brome grass, timothy, and redtop are the leading hay grasses, and bluegrass is the most important native pasture grass. The growing season ranges from 100 to 130 days, and the average summer isotherm ranges from 65 to 75 degrees. The topography is level and well adapted to the harvesting of wheat with combines.

The Great Plains Region. This region extends from the Canadian to the Mexican border and includes the western parts of the Dakotas, Kansas, Nebraska, Oklahoma, and Texas, the eastern parts of Montana, Wyoming, Colorado, and



U.S.D.A. Soil Conservation Service

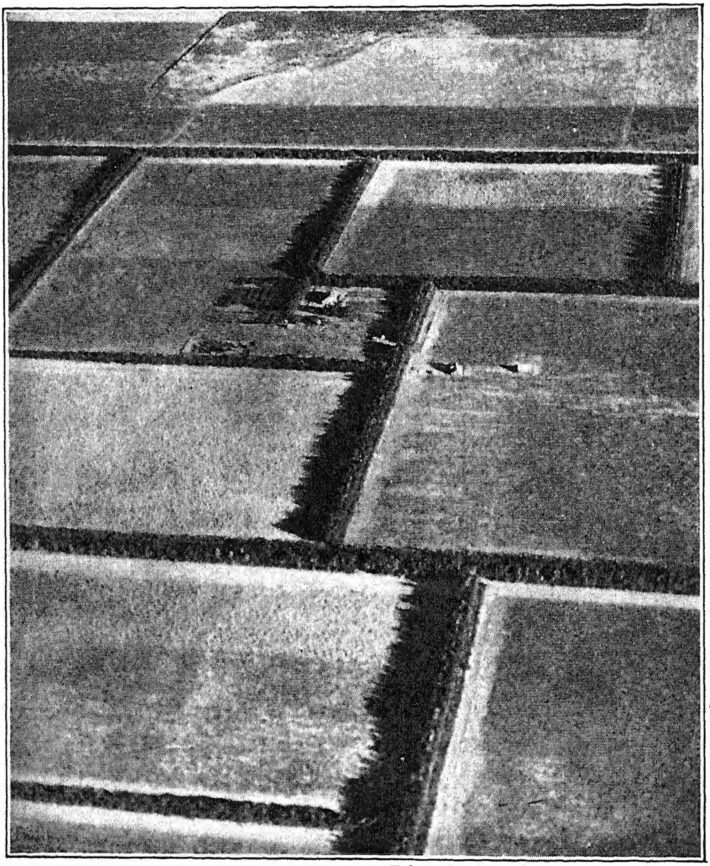
Listing to control blowing soil. The conservation of moisture and control of wind erosion and the growing of drought-resistant crops are of primary importance on the fertile, level soils of the Great Plains region.

New Mexico. In general it is a region of scant rainfall, ranging from 16 to 25 inches per year. Originally this was the short-grass prairie region which maintained enormous herds of buffalo before range cattle came with the white settlers. Much of it remains in native grasses and is a productive range country, but far too much of this land has been broken for the plow in ill-advised efforts to convert this territory into a region of cultivated crops. The severe droughts of 1934

and 1936, with attendant dust storms and the subsequent floods, brought home to the inhabitants and to the nation the fallacy of grain and cultivated crop production in this region of deficient rainfall. The territory is naturally well adapted to its native grasses, of which buffalo grass and grama grass are the most important over the central and southern parts of the area. In recent years crested wheat grass, slender wheat grass, and brome grass (*Bromus inermis*) have been grown. The most important grain and forage crops are those adapted to a limited rainfall, such as adapted varieties of sorghums, millet, and sudan grass. With the exception of areas where irrigation is practiced it is apparent that the future of this region depends on the maintenance and establishment of adapted range grasses and the continuance and future increase in the grazing of cattle and sheep in a program of controlled grazing.

The Rocky Mountain Region. The agricultural areas of this region consist mostly of valleys, table lands, and plateaus. The greater part of the area consists of non-agricultural lands unsuited even to grazing. Many of the valleys, however, particularly those that are irrigated, are important agriculturally. In the northwestern part of this region, Idaho, Montana, Washington, and Oregon, certain areas produce much wheat, barley, oats, alfalfa, hay, and alfalfa seed. The production of seed-crops in general including alfalfa, and clover seed, vetch, sweet clover seed, canning peas, field peas, beans, and potatoes is of major importance.

The North Pacific Region. The rainfall of this region is ample, ranging from 30 to 60 inches. The growing season extends from 130 to 180 days. Wheat, oats, and barley are leading crops, and the average yields per acre are among the highest in the United States. The region is marked by abundantly yielding pasture and forage crops, particularly alfalfa and clover, for a well-developed dairy industry. Canning and truck crops are somewhat important.



U.S.D.A. Soil Conservation Service

A prosperous farm with farmstead and fields protected by windbreaks (Wichita Soil Conservation District, Texas.)

The South Pacific Region. In the northern part of this region the climate is temperate and the average growing season ranges from 130 to 150 days. The rainfall, generally ranging from 10 to 35 inches, is deficient. Wheat, oats, barley, rye, and rice, produced usually under irrigated conditions, are leading crops. The southern part of this region is semi-tropical. The production of oranges, grapefruit, and other citrus fruits is highly developed. Field-beans and alfalfa are important crops. The production of vegetables and truck crops, particularly winter vegetables, is a leading industry. Irrigation is necessary over the greater part of this region.

Consider Temperature, Precipitation, and Sunlight in Relation to Crop Production. *The Temperature and Crop Production.* Cultivated crops cannot be grown where the temperature remains continually below 32° F. or above 122° F. Wheat and corn are grown in a region where the annual temperature is between 39° F. and 69° F.; oats and barley, 28° F. to 68° F.; rice, 68° F. to 86° F. The germination of seeds, as well as the growth of plants, is particularly influenced by temperature. J. Warren Smith, in his *Agricultural Meteorology,* gives the following table of the mean daily temperature of the average date of planting various important crops:

Spring wheat	37°–40° F.
Oats	43°
Potatoes	45°
Corn	55°
Cotton	62°–70°

Precipitation. Crop production is directly dependent upon moisture, either as rainfall, snow, or water vapor. Cultivated crops vary greatly in their water requirements and hence in their climatic adaptation. The following table from Smith [1] shows the pounds of water required to produce a pound of dry matter of the leading cultivated crops:

[1] J. Warren Smith, *Agricultural Meteorology,* The Macmillan Co., 1928.

Water Requirement, Pounds of Water per Pound Dry Matter

Alfalfa (average)	831
Alfalfa (Grimm)	963
Alfalfa (Peruvian)	651
Barley	434
Buckwheat	578
Corn	368
Cotton	646
Flax	905
Millet	310
Oats	597
Rice	710
Rye (spring)	685
Sorghum (average)	322
Sorghum (dwarf black hull, Kaffir)	285
Sugar beets	395
Wheat	513

Such crops as rice, cotton, corn, and wheat can be produced only if the rainfall is ample. In semi-arid and sub-humid regions, the grain sorghums and millet are of importance.

Sunshine. Light is important in building plant structure, and an increased amount of sunshine produces large quantities of sugar and starches. Sugar beets, for instance, require long days in which to produce a high sugar content. There is ample sunlight for crop needs in nearly all localities in the North American continent.

Investigate the Climatic Adaptations of Crops. *The corn crop* is at its best in regions having warm growing seasons with ample and evenly distributed rainfall. Corn is not successful in regions of cool nights and cool, cloudy days; hence its production is not extensive along the northern border of the United States. The western limitation of the Corn Belt is caused by lack of rainfall and uneven precipitation. The mean summer temperature of the Corn Belt ranges from 70° F. to 80° F., with an annual precipitation of 25 to 50 inches and 3 to 4 inches per month in July and August. The growing season ranges from 120 to 180 days in corn-growing regions and

from 130 to 150 days in the Corn Belt proper. Smith has shown that the July rainfall of the Corn Belt has a marked influence on the corn yield. In Ohio, for instance, during the years 1854 to 1915, each year one-fourth inch variation in the July rainfall, between 2 and 4 inches of the total rainfall for July, gave a corresponding variation in the corn yield of 1½

Alfalfa is widely adapted and thrives under northern and southern climatic conditions provided adapted varieties are planted.

bushels to the acre, worth approximately $6,000,000 for the state.

The wheat crop is widely distributed throughout the United States and Canada, but the regions of greatest importance in spring wheat production are located in the Northwestern States and Canada, and those of winter wheat production in Kansas, Iowa, and the Corn Belt. The southern border of the Wheat Belt nearly coincides with the 68° F. summer isotherm for May and June. The leading wheat districts have an annual precipitation of 20 to 30 inches. The hardest wheat, which is of highest milling quality, is produced in regions of less than 30 inches average annual rainfall.

Oats are best adapted to cool, moist climates, such as prevail in southern Canada, the Northern States, and the upper Corn Belt of the United States. Cool, wet weather at the time when grain is developing is particularly favorable. Oat varieties which require 90 to 100 days for development are usually grown in the Northern States. In the central and southern

Sugar beets do best on well-drained, fertile loams and silt loams where the growing season is comparatively cool and rainfall or irrigation water is ample.

part of the Corn Belt, short-seasoned varieties requiring 60 to 75 days are generally grown. The short-season varieties mature before they are subjected to the unfavorable hot, dry weather of midsummer in these regions.

Barley also is adapted to cool, moist regions, and is of the greatest importance in the Northern States and Canada. Barley is grown as the chief grain feed in regions too far north for successful corn production.

Rye is an important crop in the Northern States and Canada. It can be planted later than wheat and will germinate at a temperature a few degrees above freezing. Winter rye is

hardier than wheat and will thrive under conditions where winter wheat is often severely damaged by winter killing.

Buckwheat requires only 70 to 85 days to reach maturity. Cool, moist climates give best yields. Hot, dry weather at blooming time often causes flowers to blast; and the result is that seed fails to develop. Buckwheat is grown for the most part in northern regions and regions of high altitude. Grown as an emergency crop, it is planted in June or early July after corn or other cultivated crops have failed. The seed of buckwheat will germinate under exceedingly warm soil conditions, the temperature range for germination being from 45° F. to 105° F.

Field-beans are best adapted to regions of ample irrigation or rainfall, high humidity, and a rather cool growing season. The glaciated lake-bed soils of Michigan and northern New York are the leading bean-growing regions in the East. In southern California the leading bean counties border on the sea. The hot growing season of the Corn Belt is not favorable to bean production.

Soybeans, however, have much the same climatic requirements as the corn crop and are of the greatest importance in the Corn Belt. The *cowpea* and *velvet bean* require a longer growing season and are grown chiefly in the Gulf States.

Field peas are a northern crop that flourishes under cool, moist conditions. Peas will withstand, without injury, temperatures several degrees below freezing; hence they are well adapted to the northern range of states and southern Canada.

Sunflowers are proving important as an ensilage crop in the northern sections of the northern tier of states. Their optimum (most favorable) growing temperature is 14° F. lower than that of corn. The crop is also very resistant to frost injury.

Cotton is grown in regions of high temperature and ample rainfall. It cannot be grown where the average temperature for the growing season is below 77° F.

The grain sorghums are grown in regions of limited rainfall. They are drought-resistant, and they have the facility of remaining dormant between periods of sufficient rainfall. Corn, under similar conditions of poorly distributed rainfall, is killed or greatly damaged.

Sugar beets are adapted to rather cool regions of ample rainfall. Temperature is a highly important factor in the determination of the adaptation of the sugar beet. The area of sugar-beet production closely follows the 70° F. isotherm for June, July, and August and never ranges more than 100 miles each way from this isotherm.

U. P. Exp. Sta., Michigan

Sunflowers are now an important ensilage crop in northern regions too cold for successful corn production.

Irish potatoes are grown chiefly in cool, moist regions. This crop is not adapted to localities where the temperature rises to 85° F. or above for a number of days in succession. The Northern States and southern Canada are the leading potato-producing regions. Northern-grown potato seed is in demand in the states farther south because it is less ripe, is freer of disease, and is stored under conditions which prevent sprouting.

Sweet potatoes are a distinctly southern product and are grown, for the most part, south of the Ohio River.

Hay and pasture are at their best in regions of ample rainfall and where the growing weather is not too warm. The hay yield is directly influenced by the May rainfall, which has given rise to the farmer's saying, "A dry May, less hay." Whereas hay yields are increased by ample rain, the seed yields of clover, alfalfa, and timothy are increased by dry-weather conditions at the blossoming period and seed-filling time.

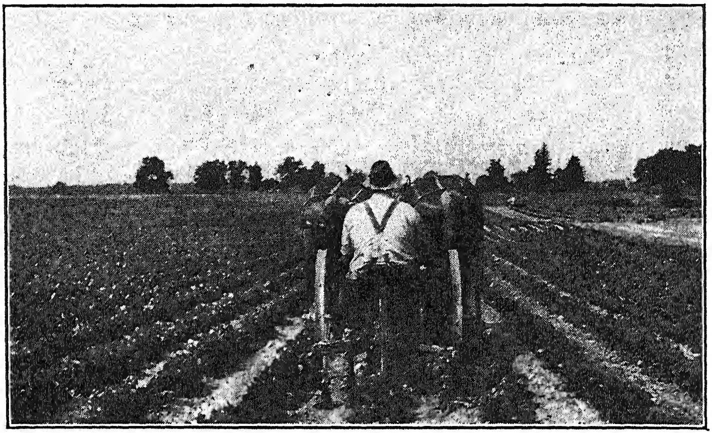
Crop varieties vary in climatic adaptation. Not only do crops differ greatly in their climatic adaptations, but individual varieties also vary greatly in this respect. Profit from crop production can be increased if the best-adapted crop varieties are grown.

Grow the Crops that Are Best Adapted to Your Soil Conditions and Most Effective in Maintaining Fertility. Crops vary greatly in their soil likings. Alfalfa, for instance, thrives on a great variety of soils, if they are well drained and well supplied with lime. Bluegrass thrives on loams and clay loams, but not on light sandy soil. Quack grass and sheep's fescue make a sod on the lighter soils. Redtop thrives on poorly drained, heavy lands, approaching swales in nature; timothy and other cultivated grasses fail to thrive under such conditions.

Soybeans make an excellent crop on land too deficient in lime for clover. Good crops of potatoes may be secured on light, sandy loam lands, whereas on heavy soils a low-quality crop is produced. Wheat, oats, and barley grow most successfully on fertile loams, silt loams, and clay loams, but will not give good results on light, sandy loams. Rye, buckwheat, spelt, and emmer give comparatively better yields on the light sandy loams.

Sugar beets give a large tonnage of high sugar content on a silt loam, but a small tonnage and low sugar yield on a sandy loam. Sugar beets on muck may give a high tonnage, but a low sugar yield per acre, because the sugar content of the beet is low.

The following general discussion aims to show some of the more marked soil adaptations of crops. It must be understood, however, in these descriptions and general statements, that, if any particular soil is properly handled, the variety of crops produced can be greatly increased.



Michigan

Navy beans do well on fertile loams and silt loams in Michigan and New York, in regions tempered by the Great Lakes, and under irrigated conditions in Idaho and in California. The hot growing season of the Corn Belt is adverse to navy bean production.

Choosing Crops for Sandy Soils. Judgment must be exercised in the choosing of crops adapted to soils of light texture. In general, the cultivated grasses and most of the grain crops are not well adapted to lighter soils. Leguminous crops, such as sweet clover, alfalfa, soybeans, mammoth and red clover, and sand vetch, are well adapted to sandy loams. Seed production of leguminous crops is usually greater on light soils than on more fertile soils of heavier texture. Sweet clover, alfalfa, and clover produce highest seed yields on sandy loams, possibly because the forage development of these crops is retarded on such soils. Leguminous crops are necessary in the

handling of light soils, because they add organic matter and nitrogen. Light soils are usually droughty and hence in great need of organic matter, to aid in the retaining of moisture.

Potatoes of best quality and highest yield are secured on sandy loams if they are properly handled. The potato crop ranks as a leading cash crop on such soils. Beans can be grown with success in rotation on light land. Rye will give much better results than wheat on sandy loam soil, and buckwheat will often give larger yields than barley or oats. On level, sandy areas where danger from frost is great, root crops, peas and oats for forage, and sunflowers for ensilage will give greater and more dependable yields than corn for ensilage and forage.

Pickles and melons are important cash crops on light soils. On the better class of sandy loams, canning peas, sweet corn, and other canning crops are of importance.

Very light or infertile sandy soil should not be utilized for crop production, since the returns seldom pay for the cost of production. Such land should be used for forestry purposes or for such pasture as it will provide.

Loams, Silt Loams, and Clay Loams. Loams, silt loams, and clay loams are, as a class, strong crop and livestock soils. They are natural grass and hay soils. Pastures of bluegrass and mixed grasses thrive; and the hay grasses, such as timothy, orchard grass, and redtop, give highest yields. Alfalfa and the clovers give the best forage yields on fertile loams, silt loams, and clay loams. These soils are natural grain soils. Wheat, oats, and barley are best adapted to soils of this texture. Corn is best adapted to loam and silt loam soils, but does very well on clay-loam soils. Sugar beets and field-beans give their best yields on loams, silt loams, and clay loams. Potatoes yield well on loams, but the quality may be impaired on heavy loams.

As a class, the loams, silt loams, and clay loams rank as our best corn, small grain, pasture, hay, and general field-crop

soils. They maintain a high development of crop production and livestock feeding.

Clay Soils. These soils furnish excellent pasture and hay crops. Grasses and small grains do well on clays. Clay soils are usually poorly drained, and hence tiling is necessary for sure production of corn, beans, and beets. When tile-drained and rightly handled, they take rank as fertile soils. Alfalfa and clover, particularly alsike, mixed alsike, and red and sweet clover, give high yields on clay lands.

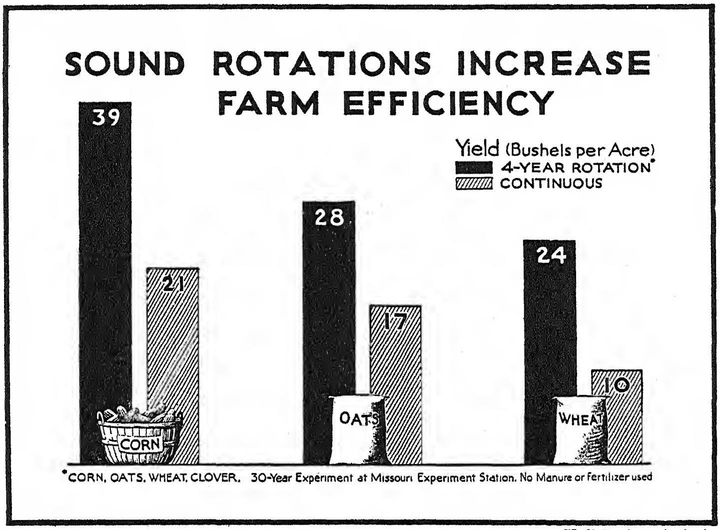
Muck Soils. On such soils a high degree of specialized truck farming has taken place, but a great part of the muck area is utilized for general farming. Of the truck crops, cabbages, celery, lettuce, and onions are most widely grown on mucks. The peppermint crop is grown to the greatest extent on such soil. This industry has developed almost wholly in muck-soil areas. Hemp gives good yields on muck.

In northern districts, corn is often frosted on muck soils, and sunflowers give better results for ensilage. Where frost danger is at the minimum, muck soils give excellent yields of ensilage corn and, if properly fertilized, of grain corn. Root crops do well on well-drained mucks. Sugar beets on such soils have a low sugar content unless the soil is properly fertilized. Rye does better on muck land than wheat. An early variety of oats usually gives larger yields than a late variety, and barley tends to lodge on muck more than early oats.

On well-drained muck, timothy and alsike make the best combination; or, if drainage is not sufficient for good timothy, redtop and orchard grass should be used. Reed's canary grass is now grown with good results on muck soils in Michigan, Wisconsin, and Minnesota. Sweet clover is apparently one of the legumes best adapted for muck soils, and large yields for pasture or hay can be secured.

In general, not only must the right crops be chosen for particular soils, but the right rotation must be planned, and the soils must be managed and fertilized in accordance with their

needs. Loams, silt loams, and clay loams are usually benefited by fall plowing to 6 or 8 inches or by early spring plowing to 6 inches. Light loams and sandy loams should be plowed to shallow or medium depth and well firmed with weighted roller or cultipacker. Light soils should be plowed as little as pos-



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Good rotation practices are fundamental in efficient crop and livestock production.

sible. Muck soils should be plowed to medium depth and well compacted with roller or cultipacker.

Crop rotations on many of these soils must be supported by applications of manure and mineral elements of fertility. Muck soils need applications of potash, phosphorus, and often lime. They usually need drainage. Light sandy lands are benefited by applications of complete fertilizers. They are benefited more generally by liming than heavier soils. Light soils are generally in need of organic matter. Loams, silt loams, and clays are apparently most benefited by applications

of acid phosphate, used properly with crops in rotation. The clays and heavy loams pay best returns when tile-drained.

Grow the Crops that Can Be Marketed Most Effectively Either Directly or as Feed for Livestock. Market conditions often influence the possible returns from crops to such a degree that it may pay to grow crops on soils to which they are not especially well adapted. For instance, potatoes are produced extensively on heavy soils in the vicinity of large cities. A better quality of crop can be obtained on fertile sandy loam soil. Nevertheless, the nearness to the market may make potatoes profitable even though the soil is not particularly well adapted to them.

The export market is a most important factor in influencing wheat and rye production. In Michigan, for instance, the production of rye decreased from 900,000 acres in 1919 to less than 126,000 in 1945, because the export demand for rye decreased. The wheat crop has been greatly reduced in acreage since World War I particularly in regions not best adapted to wheat.

The development of the demand for native-grown alfalfa seed in the United States has greatly stimulated the production of seed of Grimm and other hardy strains in the Northwest. The high freight rates, on the other hand, have made it impractical to continue the production of alfalfa hay in western states for sale in eastern markets. There has, therefore, been a great increase in alfalfa acreage in the Corn Belt and northern states.

Knowledge of production conditions in other important producing areas is often a valuable guide in determining crops. If dry weather in California reduces the bean acreage, a Michigan or New York bean grower, if he hears about it in time, will usually do well to plant a good acreage to field-beans. "In and outers," however, seldom do as well as the farmers who choose crops for annual production which are best adapted to their conditions and which meet with a stable demand on the market.

SUGGESTIONS

Study climatic and soil adaptation of crops in your locality.

1. In your locality what is the average date of the last killing frost in the spring?
2. What is the average date of the first killing frost in the fall?
3. What is the length of the growing season between killing frosts?
4. What is the average temperature in your region?
5. What is the average monthly rainfall during the growing season?
6. What are the leading crops grown in your community?
7. Discuss length of growing season of important local crops and rainfall and temperature requirements of each.
8. What leading staple crops are not well adapted to the climate of your locality? Why?
9. Which of the following crops resist frost injury in the spring: beans, peas, corn, beets, potatoes, cabbages, and sunflowers?
10. What crops are grown to the greatest extent on the heavy soils of your locality? On the intermediate soils or loans? On the light soils?
11. What crops occupy the poorly drained cultivated land? The muck soils?
12. Describe local soils where best yields of the following crops are secured: corn, potatoes, oats, wheat, barley, clover, alfalfa, timothy, and mixed hay and pasture.
13. Describe characteristics of "earliest" soils in your locality—texture, drainage, topography, air drainage, exposure, fertility, altitude.
14. Ask informed farmers about your neighborhood soils commonly termed "late soils." Describe texture, drainage, topography, air drainage, exposure or "lay," fertility, altitude.

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CHAPTER IX

SECURING THE BEST CROP VARIETIES

Heredity is the property of all forms of life. D. F. Jones

The farmer takes into partnership the growing things, both plant and animal, that he produces on his farm. The crops that he plants and the grasses and other plants that grow naturally are the development of ages of natural selection, aided in the case of the cultivated plants by man's selection. At the beginning of the present century a new force was brought to bear on the improvement of our crop varieties—the science of the modern plant breeder. Truly surprising results have been secured by the plant breeders of our experiment stations and by private plant breeders in the betterment of yield, disease and insect resistance, drought and frost resistance, market quality, and other factors contributing to the usefulness of a large number of our leading crops. Plant breeders, by ingenious methods, have brought into being new and improved crop varieties, superior in yield and quality to any previously known in the world's history.

Contributions of Plant Breeders. It has been said that planting the seed is the most important operation in crop production. Perhaps equally important is the choice of the variety to be planted. A modern farmer should "put to work" for him in the field the most vigorous, productive, and disease-resistant "life lines" that can be secured in the wheat, corn, potatoes, alfalfa, or other crops upon which the success of farming depends.

Since earliest times, when life began, plants have been subjected to the forces of nature. Beginning with simple forms of

life a multitude of plant species adapted to varying soils, climates, and uses have developed. Our primeval forefathers made use of many of these plants in their wild state for food and clothing, and, at some early period, before the beginning of recorded history, man learned to select and plant seed and

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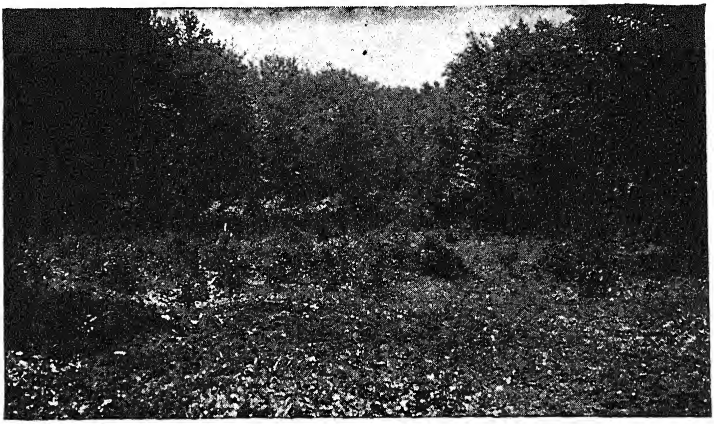
Detasseling a corn plant of a strain selected to bear hybrid seed ears.

to protect the crop until maturity from the encroachment of weeds and the depredations of animals or of other tribes. When man settled down to grow crops and was assured of a food supply, civilization as we know it, with its development of arts and crafts, exchange in trade, government, and religion, began. Wheat and barley, very similar to present-day varieties, has been found in the oldest tombs of Egypt; corn, much like the corn of today, has been found in the remains of ancient Indian cities of Mexico and Peru, cities that antedate all historic record. American farmers are the direct heirs to the useful crops developed through ages of selection and conserved

from generation to generation by farmers of the Old World and the New.

From the Old World, our forefathers brought with them to America seeds of wheat, rye, oats, barley, clover, alfalfa, bluegrass, timothy, redtop, many other grasses and legumes used for hay and pasture, peas, many varieties of beans, melons,



An old Indian corn clearing on the banks of St. Mary's River, Michigan. In similar small clearings in forested regions of America, the Indians planted their patches of corn before the advent of the white man.

and nearly all our garden crops. From the Indian farmers of America, our forefathers secured important crops, new to them at the time, which have since become of primary value to the agriculture of America and the world in general. These crops of Indian origin are corn, the white potato and sweet potato, the white pea-bean, tobacco, tomato, and certain varieties of squashes and pumpkins.

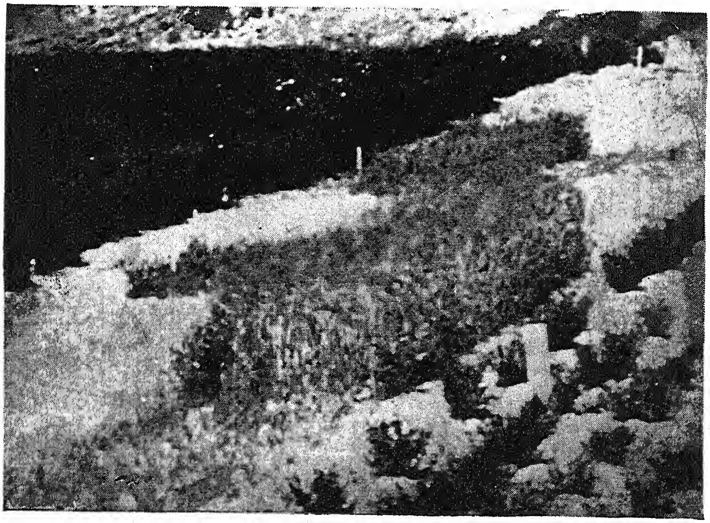
In early Colonial days, experiments were made with crops grown in many climates. Rice and indigo were once important crops in the Carolinas. Benjamin Franklin, whose inquiring intellect invaded all divisions of knowledge, plucked a seed from the straw of a broom used in sweeping his print shop,

preserved and planted it, and thus introduced the growing of broom corn and the broom industry to America. George Washington's carefully kept journals record many trials at Mt. Vernon of English clover, grasses, and lucerne. Thomas Jefferson, while ambassador to France, sent back to Monticello many varieties of European plants.

The Work of the United States Department of Agriculture and State Experiment Stations. It was a natural development, therefore, that at an early date in our history as a nation a department of agriculture was created. One of its primary duties was the securing of promising plants from other countries and the improving of these introduced plants, as well as our native plants, for use in America. Plant explorers of the Department of Agriculture have virtually searched the far corners of the earth and have introduced many crops of tremendous value. These crops include sorghums and sudan grass, which opened to profitable agriculture great areas of land west of the Corn Belt where rainfall is not sufficient for corn growing; hardy alfalfa varieties, such as the Ladak from the high plateaus of Turkistan; hard winter wheat varieties such as the Malakof; and the Durum, a macaroni wheat from the Black Sea region of Russia. Of late years Korean lespedeza and improved varieties of soybeans from Manchuria and Japan have been sent to department plant breeders by intrepid explorers. These crops now occupy several million acres of our cultivated land. Plant explorers have been sent to the South Sea Islands to bring back disease-resistant strains of sugar cane. One of these daring explorers, while pursuing his search for native strains of sugar cane of value in plant-breeding work, actually mapped for the first time a great part of the interior of New Guinea, the country of the head hunters.

This great wealth of plant varieties, developed through ages of natural selection and centuries of improvement through selection by man, constitutes the foundation of our agriculture. Since the rediscovery of Mendel's laws of heredity in 1900,

the new science of plant genetics or, as commonly termed, plant breeding, has been applied to improve practically all our leading crop varieties. Such progress has been made in the development of new varieties by pure-line selection and hybridization and in adapting these varieties for general use that to



Michigan Exp. Sta.

From this small patch of rye planted from seed from Russia, in 1908, selections were made by plant breeder Frank Spragg and the best increased for field planting. The Rosen rye is now one of the most widely grown and highest yielding rye varieties of northern states.

farm without the aid of these highly efficient varieties is a serious handicap to the producer.

The work of the plant breeders in our departments of agriculture and experiment stations has resulted in many outstanding varietal improvements, particularly since disease resistance as well as improvement in yield and quality has received scientific attention. Some of these outstanding improvements are: the development of hybrid corn varieties; the Kanred wheat, resistant to black stem rust, developed at the Kansas Experi-

ment Station; the smut-resistant Markton oats of the Washington Experiment Station and the Clinton oat of the Iowa Experiment Station; the Mosaic-immune robust bean of the Michigan Experiment Station; the Well's red kidney bean, resistant to anthracnose, developed at Cornell University; the Yellows-resistant cabbage variety from the Wisconsin Experiment Station; the Washington rust-resistant strain of asparagus, developed at the Arlington Station of the United States Department of Agriculture; and the Atlas sorgo, developed at the Kansas Experiment Station in cooperation with the United States Department of Agriculture; the wilt-resistant Ranger and Buffalo alfalfa varieties from the Nebraska and Kansas experiment stations.

Private breeders have also made remarkable contributions; one of the most noted is the Burbank potato.

The above are given as examples; more complete specific recommendations of varieties are presented in discussions of specific crops in following pages.

Plant-Breeding Methods. The following methods are employed in plant improvement:

1. Selecting promising types of self-pollinated plants (single plant selection).
2. Selecting superior individuals of cross-pollinated and self-pollinated plants to reduce to pure lines and to fix desired qualities.
3. Selecting best individuals from plants in which cross-pollination is obligatory, on the basis of either self-sterility or their dioecious character, and restricting pollination to this group of plants alone.
4. Hybridizing or cross-pollinating strains of both normally self- and cross-pollinated plants to secure desirable types which may result, combining the good qualities of the parent plants.
5. Selecting superior individuals of either cross- or self-pollinated plants and planting selections together for increase (mass selection).
6. In vegetatively propagated plants, selecting tubers, root cuttings, shoots, stolons, or bulbs from desirable parent plants.

7. Maintaining testing plats to compare new selections of promise with strains of known habits of growth and value.
8. Isolating increase fields for multiplying cross-pollinated plants.

Selecting Promising Types of Self-Pollinated Plants. Wheat, oats, barley, vetch, beans, and field peas are examples of normally self-pollinated plants of field crops. Peas, beans, lima beans, tomatoes, peppers, and lettuce are normally self-pollinated vegetable crops. Occasional cross-pollination in the field occurs with each of the above-listed field and garden crops.

Many useful varieties of self-pollinated plants have been developed when a desirable plant was selected in the field and its seed was reserved for increase by separate planting and harvesting.

The modern plant breeder, however, secures more certain results. He selects several hundred or more desirable plants from the field or selection bed, harvests each separately, using a readily cleaned hand separator, places the seed from each plant in a properly numbered envelope or small bag, and stores carefully in insect-proof containers until the next planting season.

Progeny rows of equal length are planted (usually in duplicate series) from the seed of each marked envelope, and designated by small stakes carrying the respective identification numbers. The growth of each progeny row is observed during the season, and proper notes are taken. At harvest time, each row is harvested separately, the plants are tied in bundles marked with assigned numbers, cured, and threshed in a small separator. The seed from each progeny row is inspected, weighed, and placed in small bags carrying identification numbers.

In small grains, the seed from the progeny rows that show the heaviest yield of grain of best market quality and other desirable qualities, such as stiffness of straw, maturity at right time, comparative absence of tendency to shatter, freedom

from, or resistance to, disease is reserved for planting the following season.

The next planting season, rod-rows (rows one rod long) are planted in series and properly numbered; usually two to four replications are made of the desirable strains, and the remaining seed is reserved in bags carrying the respective strain numbers. Careful field observations of resistance to disease, stiffness of straw, time of maturity, and other characteristics are made and properly noted for the rod-rows of each strain. The rod-rows are harvested, threshed, and weighed separately. The outstanding strain may be ascertained and the seed of all rod-rows of that number may be combined for increase the next year, or several more seasons may be given to further testing. For purposes of comparison, rod-rows of a standard variety of known yielding ability are usually included, from the second year on, as check plats.

When enough seed of a strain selected as superior is secured, it is planted in an increase plat and is also included in a varietal series with standard varieties of known worth. If the selected strain continues to demonstrate superior yielding ability, disease resistance, and other desirable qualities, the seed is increased to the point at which enough is secured for extensive field planting. Since all the seed came, originally, from a single plant, the new variety is a pure line or single strain. Before general distribution is made, regional varietal tests should be conducted on representative soil types, with a standard variety of known value used as a check and with local varieties included for comparison.

The eventual distribution of the new strain should be in accordance with its proved yielding ability and adaptation to the soil and climatic conditions of various localities. Such work is now effectively conducted by the Bureau of Plant Industry, United States Department of Agriculture, and by the experiment stations of nearly all states and Canadian provinces.

Modern Corn-Breeding Methods. No recent development in plant breeding has given as spectacular results in yield improvement as the development of corn hybrids. Through the skillful selfing (self-pollination) of individual strains to secure desirable pure lines and the crossing or hybridizing of these pure lines by corn breeders, hybrids have been produced which possess yielding ability above all known standard varieties. These corn hybrids, developed by experienced corn breeders and grown under their supervision by farmers and by seedsmen, constitute a highly important phase of modern corn growing. The corn hybrids produced in the various states according to adaptation are replacing very rapidly the seed of standard corn varieties developed by ordinary selection methods. *Only the first generation secured by crossing the proper hybrids maintains the highest yielding ability;* hence the seed-corn grower who successfully produces the best corn hybrids is assured a constant and a rapidly increasing market.

A large number of corn plants are self-pollinated for several seasons to secure pure lines, the resulting ears are tested in ear-row plats to observe yield, maturity, and other qualities, and a numbered remnant is reserved of each selfed ear planted in the test.

The remnants of the best strains, as indicated by the ear-row test, are reserved for future planting and hybridization. The selfed ears of corn are usually of small size and insignificant in appearance, and, when kernels from selfed ears are planted, the resulting plants and ears do not compare favorably, as a rule, to normally hybridized plants. Proper crosses or hybrids made from the best strains, as shown in yield tests, often give surprising results in yield increase, particularly in the year after the season when the pure lines are hybridized. Such hybrids seemingly do not maintain their yielding ability but decrease in yield year after year, so that, if this method of crossing a small number of pure strains is to be of greatest value, elaborate breeding work by skillful plant breeders must be

maintained, and growers must be informed that they must secure seed from first-generation crosses for planting each year and must not depend on seed selected from their own fields for maintenance of high yielding ability.

Michigan Exp. Sta.

Self-pollinating corn. The "selfed" ear is covered with a paper bag.

By recombining selected pure lines, undesirable lines of heredity existent in our common corn varieties are eliminated. Corn, since it is open-pollinated, is hybridized to a large degree by the planting of alternate rows of the varieties to be crossed, and the detasseling of one variety. Artificial hybridization of corn is more accurately controlled if the developing ear is covered with a paper bag securely clipped or tied at the shank of the ear. The tassels (or male part of the corn flower) of a

number of the strains selected for male parentage are protected by bagging forty-eight hours before pollen is to be used.

When the pollen in the bagged tassels is ripe, and the silks of the protected ears of the detasseled plants are advanced in growth to a receptive condition, pollen is transferred to the plants selected for female parentage. A bagged tassel is cut off below the bag, shaken vigorously, and carried to the covered ear. The bag covering the protected ear on the detasseled plant is removed, and the pollen-carrying bag is placed over the ear. The bag covering the ear is then immediately closed, given a vigorous shaking, and fastened around the shank with a clip. The introduced pollen strikes or pollinates the silks or stigmas, and fertilization is accomplished. Placing the butt end of the cut-off tassel in a small bottle partly filled with water, attaching the bottle with a wire hook to the ear shank, and placing covering bag over ear and tassel are late developments in improved technique.

Rye Improvement. Excellent results have been secured by careful plant selection and by the proper isolation of individual rye plants to prevent crossing with other rye plants. If the individual heads of desirable rye plants are covered with glassine bags, self-pollinated kernels are produced which form the basis for further improvement of rye varieties. The inbred strains may be tested in short rows, and kernels of each reserved in an envelope; small stakes at the end of each row may be marked to correspond with the numbers given envelopes holding grain from which the rows are planted. The rows giving best yields indicate the most desirable remnants, the best of which are combined in an isolated increase plat the next year.

Timothy Improvement. Marked improvement in timothy has been secured by the testing of rows of timothy planted from individual plants by *clonal* division (roots and stolons of individual plants are divided and transplanted in short rows). The best rows are individually isolated to assure selfing and obtain increase of the new strains. The ease with which these

new pure lines of timothy cross with the ever-prevalent wild and cultivated timothy plants throughout the timothy-growing regions and the tardiness of farmers and the general market to adopt improved timothy varieties have caused much valuable work with timothy to have little practical value up to the present time.

Selecting Best Individuals from Plants in which Cross-Pollination is Obligatory, on the Basis of either Self-Sterility or Their Dioecious Character, and Restricting Pollination to this Group of Plants. Asparagus, spinach, and hemp are dioecious, the male plants producing pollen which is necessary in the successful fertilization of the receptive flowers of the female plants. Many strains of cabbage and beets are self-sterile.

Hybridizing or Cross-Pollinating Strains of Both Normally Self- and Cross-Pollinated Plants to Secure Desirable Types which May Result, Combining the Good Qualities of Both Parent Plants. Although desirable new varieties result from occasional natural crosses which occur in the field, modern plant breeders increase the range of possibility of securing desirable new hybrids by the artificial crossing of large numbers of plants grown under careful observation. Plants of male and female lines of parentage are carefully selected in large numbers, and many combinations of lines of heritage are made.

In crossing self-pollinated plants, such as wheat, oats, and barley, the common procedure is to strip alternate spikelets from the spikes or heads of selected plants before pollen is produced in the anthers, force open the glumes of remaining flowers, and emasculate by removing the anthers with delicate forceps. The emasculated flowers are protected from cross-pollination by covering the spike or head with narrow bags of glassine paper securely closed and fastened with clips at the base of the spike. When stigmas are ripe, anthers carrying ripe pollen are collected from flowers of plants selected for male parentage and placed, for transference, in a small tin box with tight lid. The glassine bags covering the emascu-

lated flowers (the female lines) are removed, and the collected pollen is quickly transferred by means of a camel's hair brush to the stigmas of the emasculated flowers. The glassine bags are immediately returned and clipped securely. The resulting kernels are, of course, hybrids of the emasculated plant (fe-

Seed Production and Marketing—Cox and Starr

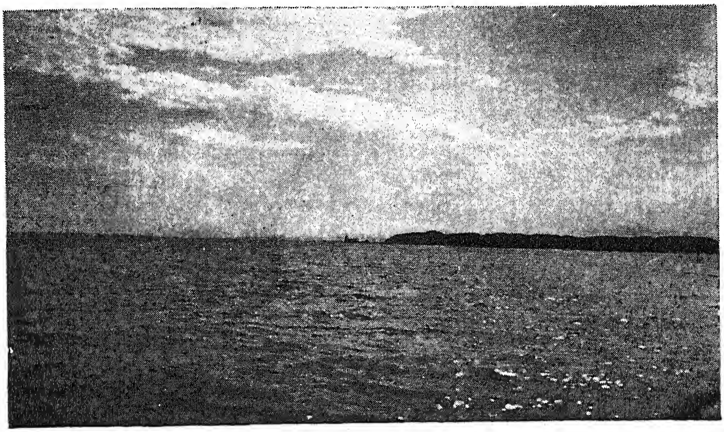
A plant breeder crossing desired strains of barley. Pollen-bearing parts of the flowers are removed from the mother plant. Pollen from the plant selected as desirable for crossing is brushed on the stigma of the mother plant with a camel's hair brush; the spike, or head, of the mother plant is then covered with a glassine bag to prevent cross-pollination.

male parent) and the plant producing the pollen used in artificial fertilization (male parent).

Selecting Superior Individuals of Either Cross- or Self-Pollinated Plants and Planting Selections Together for Increase. The crop-improvement methods of most farmers and seedsmen are limited to mass selection. Examples of this method of improvement are the selection in the field of ears of corn borne on most desirable plants, the head selection in the field of cabbage plants for seed purposes, the plant selection of beans and peas, and the head or plant selection of wheats and oats.

Common varieties of radishes, cabbage, wheat, oats, barley, peas, beans, and many other plants are often improved by mass selection.

In Vegetatively Propagated Plants, Selecting Tubers, Root Cuttings, Shoots, or Bulbs from Desirable Parent Plants. The hill and tuber-unit selection of potatoes gives marked improve-



South Manitou Island, several miles off the shore in Lake Michigan, was selected for rye improvement work in order to prevent cross-pollinating with common rye.

ment in type and yield of average commercial varieties. Selecting superior plants of rhubarb for root division, results in much better plantings. Multiplier onion and garlic crops are improved by the selection of bulbs from the types best for transplanting.

Maintaining Testing Plats to Compare New Selections of Promise with Strains of Known Habits of Growth and Proved Value. The rod-row system, with frequent checks and several replications, is used by most plant breeders.

The trial beds of seed companies are usually large beds planted for observation; they include rows of known varieties for comparison.

The systematic methods employed by the breeder of field crops are now being used by the most successful practical seed growers of garden-crop seeds.

Isolating Increase Fields for Multiplying Cross-Pollinated Plants. The proper isolation of increase fields of cross-pollinated plants is of the utmost importance.

Increase fields of corn must be at least 40 rods away from other cornfields. A greater distance is desirable to prevent crossing.

Rye increase fields should be isolated a similar distance and all volunteer rye cut before pollination occurs.

With vegetable crops, increase fields of radishes, for example, must be at least 40 rods from other radish fields. In districts where radishes are grown for seed, volunteer radish plants cause great difficulty. Radish plants from seed disseminated from gardens or seed fields may take their place among the common field weeds and continue as a pest for years.

Many plants not only cross within varieties but also freely intercross with closely related members of the same family. Beets cross freely with swiss chard and mangels, and the resultant crosses are of little value. Cabbage, cauliflower, kale, kohlrabi and other members of the *Brassicaceae* family freely intercross.

SUGGESTIONS

1. Make a list of the varieties of crops grown on home farms. Bring samples of the various crops to school for examination. Probably it will be found difficult to identify the grain crops because the same seed has been used year after year and a great amount of mixing has occurred.

2. Secure literature from the state experiment station describing the tests of various crop varieties and of the various strains within varieties. Much of the information will be in the form of tables which show the variations in yields and other characteristics. Study the information for varieties and strains which may be of service in a local community.

3. Arrange to visit an agricultural experiment station. If plans are made in advance, some of the experiment station scientists engaged in plant breeding will be pleased to describe and demonstrate how the

work in plant breeding is done. Before making such a trip, students should discuss the meaning of such terms as stamens, pistil, pollination, fertilization, cross-pollination, hydridizing, progeny, pure lines, sterility, propagation, and emasculation. If students have a fair understanding of such terms, the plant breeder will have much less difficulty in explaining the work he does.

4. The information in this chapter is rather difficult to understand unless the teacher and students go over the material carefully. Review some of the information about flowers found in Chapter IV. Examine flowers and heads of grain and learn thoroughly their characteristics. Put diagrams on the blackboard to illustrate the work done by plant breeders.

5. In the Corn Belt where corn is such an important crop, a particular study should be made of hybrid corn. In such states it will be found that corn-breeding work has been carried on intensively at the experiment stations. The work and progress in corn development are usually available in bulletins. Students are strongly urged to visit an experiment station where corn-breeding work is in progress.

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CHAPTER X

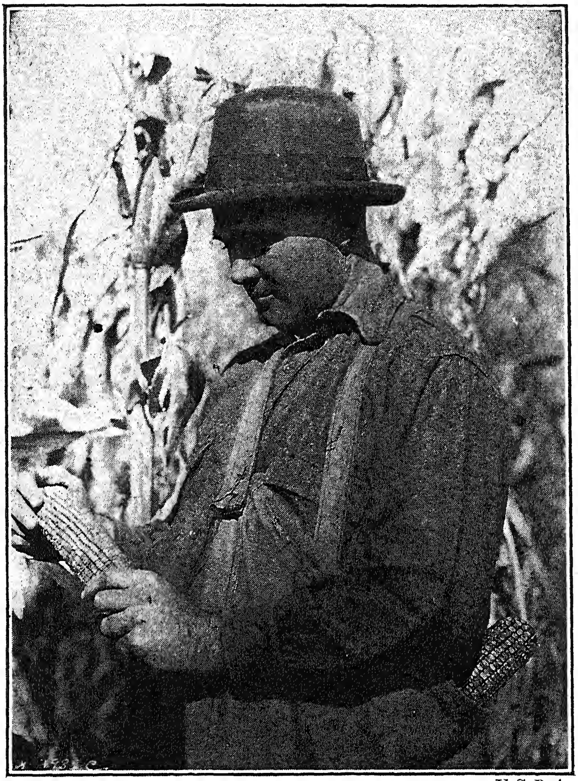
GROWING SEED ON THE FARM

Civilization depends for continuance on the seed saved each year for planting the next.

Present-day farmers realize as never before that great variations exist in varieties, breeds, and strains of the crops and the livestock upon which they depend for a successful living. Those who give greatest attention to securing the highest-producing varieties of corn, wheat, alfalfa, clover, potatoes, and other crops get by far the greatest returns from the effort and expense applied to the plowing and fitting of the soil and from the planting, cultivating, and harvesting of the crop. It behooves the farmer to secure the best available hereditary strains in the production of all living things on the farm—field crops, truck crops, fruit, and livestock. Not only do varieties vary greatly in yield, but modern plant breeders have also shown that varieties, and strains within varieties, of our standard crops vary greatly in resistance to disease and insect injury, in adaptation to soil and climate, and in quality of the harvested product used for human consumption or for livestock. Smut- and rust-resistant wheat and oats varieties developed by plant breeders are now available in many states; chinch bug- and corn borer-resistant corn varieties have been developed; potatoes of high resistance to disease and superior market qualities are available; and domestic red clover not only is much hardier than European red clover but is much less affected by anthracnose and other fungus diseases of red clover plants.

All available information on the highest-yielding and best-adapted varieties that are locally important should be se-

cured from state experiment stations, the United States Department of Agriculture, and dependable seedsmen.



U.S.D.A.

The grower of seed of high-yielding adapted varieties renders an excellent service in his neighborhood, with profit to himself.

Producing Seed for Sale Offers Splendid Opportunities. In nearly all communities a strong demand exists for good seed of the best-yielding varieties in the locality. Farmers have developed increasing confidence in seed that is grown locally by growers of ability. In addition to this local marketing

opportunity, seed distributors, both cooperative and private, contract extensively with individual seed growers for the production of seed-crops at prices considerably above general commodity prices.

The seed grower must be not only a master crop producer of outstanding ability in preparing seed beds, and cultivating and harvesting the crop, but also a master of practices not generally understood and employed by the average crop producer. The seed grower must know the sources of parent stock of the latest improved varieties developed by plant breeders. He must know how to keep varieties from mixing mechanically or by cross-pollination in the field. He must control weeds, insects, and diseases, particularly seed-carried diseases. He must master special methods of harvesting, storing, cleaning, and grading seed, and he must become efficient as a business man in the marketing of the seed produced. The farmer who excels in seed production and marketing raises himself to a special group of producers who receive far more for their product than the average crop grower. The business of seed growing gives full play to the development of skill and ability in production and marketing, and greatly increases the contacts of the producer with able farmers, plant breeders, and seedsmen. The seed grower is rewarded not only by higher profits that result from the production of a superior product, but also by the satisfaction of rendering service to many others whose returns from better-yielding varieties are increased.

Best Foundation Stock Must Be Secured for Seed Production. Plant breeders of state agricultural experiment stations and of the United States Department of Agriculture are engaged in testing varieties of field, garden, truck, and canning crops and in producing new and improved varieties of these crops by modern plant-breeding methods. Some of the leading seed companies of the nation maintain seed farms for the testing of crop varieties and the breeding of better varieties and strains. Farmer seed growers occasionally develop varietal improvements of widespread importance. The best seed

stocks should be secured by the seed grower, who must meet the keen competition of other seed producers constantly striving for the betterment of their seedstock and satisfy the demands of a public becoming more and more exacting in the demand for a real seed service.

Certified seed of field crops is available in quantity to crop improvement associations in more than thirty states. Élite seed, or foundation stock, may often be secured from experiment station plant breeders or from dependable growers or seed companies who have increased foundation stocks for the general market.

Crop-improvement associations effectively increase improved varieties for wide distribution. When a new variety is developed and proved, by careful comparison in field tests with other varieties, to be of superior merit, it must be brought into widespread use to be of great practical value. If released from the plant breeder's hands in small lots, the new variety would become mixed with other varieties. In spite of great merit, new varieties have small chance of achieving widespread distribution unless the seed is increased in quantity, kept pure, and made available at reasonable prices. To accomplish this purpose efficiently, cooperative crop-improvement associations, seed-growers' associations, or experiment associations have been developed in practically all states where extensive experiment station plant-breeding work is being conducted. In some states associations are formed for the production and certification of seed of special crops. Certified seed-potato growers' associations in seed-potato producing states have greatly improved the quality of seed potatoes. In the Northwestern States, associations of farmers producing Grimm alfalfa under a program of seed inspection and seed certification have made increasing quantities of certified Grimm alfalfa seed available.

State Crop-Improvement Associations and Seed-Growers' Associations Cooperate with Commercial Seed Growers. The state crop-improvement associations and seed-growers' asso-

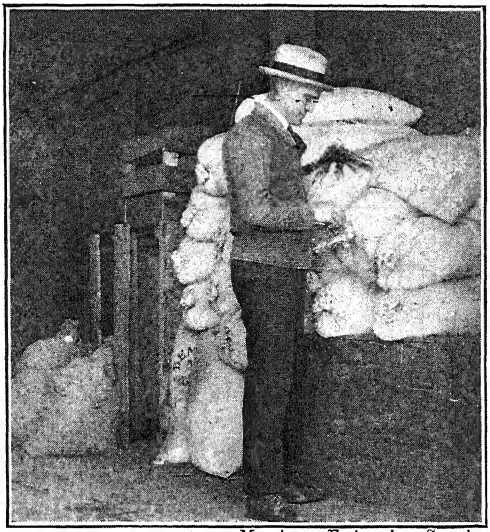
ciations include in their membership growers interested in growing and selling seed of the best available varieties, properly conditioned for the market. In many states commercial seed growers are members of the association, or they contract for large amounts of seed produced by association growers.

Montana Extension Service

A Crop Improvement Association inspection of a seed field of Grimm alfalfa. Field inspection, to determine varietal purity, freedom from weeds and disease, etc., is a basic operation in the production of certified seed.

These associations generally require field and after-harvest inspections and, through their inspection service, affix certification seals to bags containing seed meeting with high requirements of purity, germination, and seed condition. Such seed is known as certified seed since it has been inspected and certified for variety, purity, and germination by a well-qualified inspection service legally recognized by state departments of agriculture. Seed associations function in 41 states.

The crop-improvement and experiment associations of the United States have developed within comparatively recent years, the oldest being hardly more than forty years old. The formation of the International Crop Improvement Association in 1919 gave impetus to certified seed associations in many



Montana Extension Service

Affixing seals to certified seed that has passed inspection and is ready for sale.

states. This organization, which meets annually, has been instrumental in developing and standardizing improved methods of producing, inspecting, certifying, and marketing certified seed.

At most state experiment stations, many new varieties have been proved by careful tests to be superior and ready for widespread introduction. This *élite seed,* or foundation stock, is made available to outstanding growers of crop-improvement associations and, after careful field and after-harvest inspection, is certified as *registered seed* available in quantity as

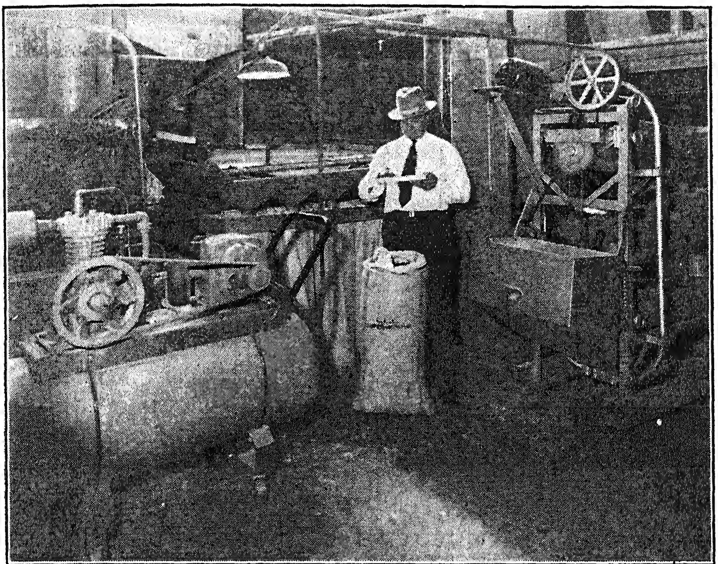
foundation stock for *certified seed growers* who desire to make further increases of the variety for sale as *certified seed.*

The cost of employing inspectors is generally carried by members of the crop-improvement associations at specified rates per acre or per bushel. The training of inspectors and the drawing up of regulations in regard to standards and requirements of certified seed are generally done in cooperation with crop specialists of the state agricultural extension service, agricultural experiment station, or state departments of agriculture. In most states, laws provide for recognition and protection of seed certification by crop improvement associations or other recognized seed-growers' associations.

Seed Is Marketed Cooperatively. With the formation of the American Farm Bureau, the cooperative handling of seed was greatly advanced. In 1920, the Michigan Farm Bureau Seed Department was instituted for the purpose of securing adapted domestic or Canadian clover and alfalfa seed, either directly from growers or from dependable dealers, and for the purpose of marketing certified seed produced by growers of the Michigan Crop Improvement Association. In 1921, the Grange League Federation of New York, an organization of the Grange, Dairymen's League, and Farm Bureau Federation, established a seed department to give to members and patrons dependable service in the sale of adapted seed of highest yielding varieties. The Grange League Federation Seed Service distributes seed over a large territory in New York and neighboring states. Since its successful development, a similar organization, the Southern States Cooperatives, renders seed service to Southeastern States, and the Eastern States Farmers' Exchange serves the New England States.

In the Corn Belt states, incorporated farm bureau services include seed distribution among their activities in Ohio, Indiana, Illinois, and other states. Nearly all these organizations are cooperatives organized under the Capper-Volstead Act of Congress; stock is owned by members, and officers are elected by the vote of members. Seed and other commodities

are handled at cost; the main objectives, as far as seed distribution is concerned, are to provide members and patrons with seed of high yielding ability and proper adaptation, free of noxious weeds and impurities, and of dependable germina-



G. L. F. Seed Service of New York

A seed-cleaning plant of a Farmer Cooperative Seed Service. Alfalfa and clover seed and other seed guaranteed as to origin, adaptation, purity and yielding ability is distributed from similar cooperatives in seventeen states.

tion—the kind of seed that will give best results in the field. In recent years not only field-crop seeds but also truck- and garden-crop seeds have been handled by these cooperative organizations.

Seed Distributed by Seed Companies Varies in Quality. Many private seed companies, like the cooperatives, make every effort to distribute to their patrons high-quality seed of varieties of known origin, adaptation, and purity. They are in

vigorous contrast to the small minority of seed dealers who sell unadapted seed and cheap seed made up largely of chaff and containing many weed seeds without regard to field performance. The latter group causes great losses to farmers and is a detriment to the seed trade as a whole. The seed laws of states and of the federal government aim to protect the public against unscrupulous or inefficient seed distributors, but it is important for individual farmers to purchase high-quality seed from dependable distributors and to avoid cheap seed and bargain lots.

Seed Crops Must Be Grown on Adapted Soil and Given Thorough Cultivation. In general, well-drained soils adequately fertile are best for seed production. Individual crops, however, have particular adaptations; the best seed potatoes are produced on sandy loams or light loams, seed corn on fertile loams or silt loams, small-grain seeds on heavy loams and clay soils, radish and melon seed on light sandy loam, and tomatoes and cucumbers on silt loam or fertile sandy loam.

New lands offer great advantages because they are comparatively free of soil-carried plant diseases, noxious weed seeds, and many insect pests. Potatoes from newly cleared lands are unusually free of common potato diseases. Peas and beans are often grown on new land to control the root rot of the pea crop and the blight and anthracnose of the bean. Red clover and aslike clover in new areas often expand in seed production because of the widespread distribution of buckhorn, night-flowering catchfly, and other noxious weeds prevalent in the older clover-growing districts.

Land Must Be Prepared Thoroughly with Best Types of Labor-Saving Equipment. Thorough fitting of the soil is of primary importance in the production of seed crops. For a vigorous and uniform growth and freedom from noxious weeds, a well-settled, finely surfaced seed bed is necessary. Fall plowing or early spring plowing destroys cutworms, wire worms, white grubs, and many other insect pests and provides opportunity for the thorough settling of the seed bed and the ade-

quate fitting of the surface soil for planting. Weeds are most economically and effectively controlled at the time of fitting the seed bed; hence the seed grower should give particular care to the job of seed-bed fitting with disk harrows, cultipackers, and smoothing harrows to reduce the labor and expense involved in controlling weeds after the crop is planted.

George and Louis Hutzler, father and son, have grown selected strains of Rosen rye on South Manitou Island, Michigan, for many years, winning many prizes at the Chicago International Grain and Hay Show.

Land well supplied with organic matter should be fertilized with a high-grade complete commercial fertilizer or with acid phosphate. Most soils are deficient in phosphorus, and, since this element is largely used in seed development, applications of acid phosphate or a complete fertilizer high in phosphorus are usually advisable on all but the most fertile soils. In the older farming sections of eastern and northern regions, 300 to 1000 pounds of a 4–8–6 or a 4–12–6 fertilizer are needed on average, used soils. On soils well supplied with organic matter 300 pounds or more of 16 per cent acid phosphate or its equivalent may be sufficient. In older agricultural areas the proper use of a phosphorus-carrying fertilizer is of utmost im-

portance in growing plump, properly matured seed-crops. An ample supply of phosphorus hastens maturity. On the surprisingly fertile soils of the western irrigated regions, mineral fertilizers are not in common use at present, although the use of fertilizer is gaining each year on the older farms of California, Oregon, and Washington. In soils used in seed production it is important that a sufficient content of organic matter be maintained, to assure moisture-holding capacity and a satisfactory condition of tilth.

Seed Fields Must Be Isolated to Prevent Cross-Pollination. In growing seed of varieties of corn, clover, alfalfa, radishes, cucumbers, melon, beets, cabbage, and many other plants it is necessary to isolate fields at distances of 40 rods or more from other varieties with which they may cross. Neighbors must frequently be induced to grow in adjoining fields the same variety that is being produced for seed by the seed grower. Volunteer plants must be destroyed; for corn, volunteer plants must be detasseled or cut before pollen is distributed.

Plant Diseases and Insects Must Be Controlled by Seed Treatment and by Growing Resistant Varieties. The seed of small grains, such as wheat, oats, barley, and rye, should be treated with semesan or copper carbonate or formaldehyde in order to control diseases that affect these crops. These treatments and diseases are dealt with specifically in Chapter XV. It is worth while for the seed producer to treat seed corn also with semesan. Seed potatoes should be treated with mercuric bichloride solution to prevent or retard scab, rhizoctonia, and blight. Where disease-free or -resistant strains are available, they should be planted, but, in general, seed treatments are advisable and are safe insurance.

Planting Must Be at Proper Time, Rate, and Depth. Since the harvested seed-crop should be plump and fully matured, it is important that full use be made of the growing season. Planting fairly early in the season for the particular crop is therefore desirable. Cool-season crops, such as peas and beets, are planted as a rule early in the spring, as early as the ground

can be fitted. Corn, beans, melons, and cucumbers should be planted when the ground is well warmed, usually in late spring. Transplanted crops, in general, should be set out when the ground is thoroughly warmed and the danger of frost is past, usually late in the spring or early in the summer. Seed-crops are generally planted at rates of planting less than the rates used for general crop production. Transplanted crops are set somewhat farther apart when grown for seed than when grown for a general crop. Potatoes, however, when whole seed tubers are desired, are generally spaced close in the row. The depth of planting varies with seed, soil, and moisture condition; peas are planted at about 3 inches; corn and beans at 1½ to 2 inches; small grains at 1 to 2 inches, according to the nature of the soil. On well-prepared seed beds, shallow planting is generally most satisfactory.

It is important to distribute seed evenly and accurately; hence the best types of seed drills and other planting machinery should be employed. Corn, bean, pea, and beet drills plant seed in rows properly spaced, marking the next rows at the same time. If large areas are to be planted, four-row drills plant more economically than two- or one-row drills. Grain- and grass-seed drills reduce the amount of seed needed per acre, plant evenly, and plant at the proper depth.

Particular care should be taken, before seed-crops are planted, to clean seed drills and planting machinery thoroughly; removing all seed which may have been retained in the drill from previous use prevents mixing of seeds. It is good practice to wash drills with a formaldehyde solution, 1 pint to 30 gallons, to kill spores of plant diseases which may be carried over from previous planting.

Using the cultipacker or roller after drilling firms the soil around the seed and insures a more rapid and more even germination of the seed.

Intertilled Seed-Crops Must Be Thoroughly Cultivated. Since larger returns are to be secured from seed-crops, more than usual attention to thorough cultivation is justified. Early

cultivation should be to a good depth, and later cultivations should be shallow. Spike-tooth harrows, with teeth slanting backwards, or weeders may be employed before plants appear above the ground. The first cultivation should be given as soon as plants appear in the rows, with tongue or shovel types of cultivator attachments, close to the plants, and fenders being used if necessary to prevent covering. Later cultivation should be made at shallow depths, 2 inches or less, with blade, duck-foot, or half-sweep attachments that slip just beneath the surface of the soil, effectively killing weeds and leaving a loose mulch without injuring the feeding roots of the plant. Frequent hoeings, with well-shaped, shallow-bladed hoes, are advisable. Weeds not controlled by hoeing or cultivating should be pulled by hand.

Off-Type Plants, Crop Mixtures, Diseased Plants, and Weeds Must Be Rogued or Pulled Out. Careful rogueing of seed-crops is important to maintain varietal purity, prevent mixtures of noxious weeds and other plants, and reduce losses from disease. Rogueing involves pulling off-type plants by hand or cutting them out with a hoe. These rogued plants should be removed from the field and burned. Weedy areas of clover or alfalfa fields that cannot be economically rogued by pulling weeds by hand should be harvested for hay purposes and not included with the areas of the field allowed to mature for seed.

Seed Must Be Harvested when It Is Properly Mature. In the handling of practically all seed-crops, it is important that the crop be harvested as soon as it reaches proper maturity and weather conditions permit. Risks of weather damage, resulting in discoloration or freezing which injure appearance, keeping qualities, and germination, increase every day that the crop stands in the field. Delay in harvesting increases the likelihood of loss through shattering and other causes, such as the depredations of animals and birds and losses from insects and diseases. Seed harvested before maturity is likely to be poorly filled, light in weight, below grade in appearance, and fre-

quently unsatisfactory in germination. Good seed should have good color, often described as bright or lively, and should be plump. Such seed can be produced dependably only by harvesting at the right time and by curing and storing properly. Efficient binders for small grains and mowers with binder attachment and vine lifters for alfalfa, peas, vetch, and other viney plants should be used. In harvesting lespedeza, a broad pan to catch seed is attached behind the mower blade. Bluegrass seed is harvested with specially constructed strippers.

Many seed-crops, such as field and sweet corn for seed, are harvested by hand. Garden seeds, including beets, radishes, cabbages, and lettuce, are hand-harvested, with hand clippers or reaping hooks.

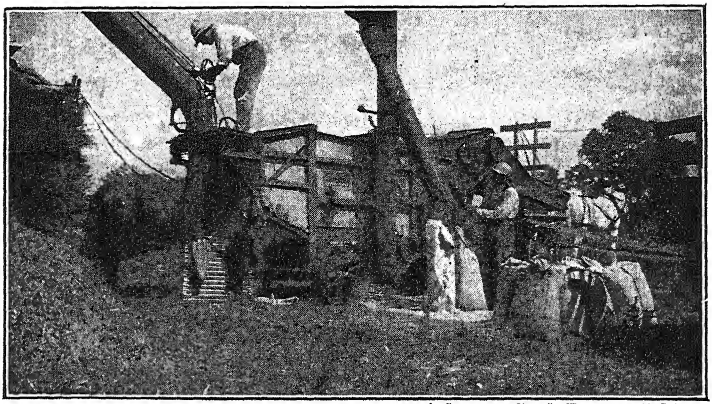
Curing Seed-Crops Is a Most Important Operation. Seed-crops of small grains, beans, soybeans, cowpeas, peas, alfalfa, and clover, after sufficient curing in the field, usually for a week or more, are generally stored in well-made stacks or in barns under roof until threshing time, to insure better color and quality of seed.

Special seed racks are employed in curing melon, cucumber, lettuce, and onion seed.

Seed-Crops Must Be Threshed Carefully. The modern grain separator is equipped with many screens, varying in sizes of mesh, which may be used in threshing a large number of field and garden crops producing seed of varying sizes. With proper adjustments of concaves and screens, standard grain separators can be used for threshing all small grains, and also for seed of alfalfa, beans, peas, and radishes. Beans and peas are best threshed by a beaner, a special thresher equipped with two sets of cylinders, one running slowly to remove overripened beans without splitting and the second running at high speed to remove tight-podded beans. The clover huller does a better job of threshing alfalfa and clover seed than the grain separator.

Specially built threshers are used in separating the seed of melons, cucumbers, and tomatoes. In these machines the

pulpy fruit passes through corrugated rolls so adjusted as to crush the fleshy fruit, releasing the seed. The pulpy mass carrying the seed passes into a slowly revolving cylinder made of screen wire of proper mesh. The cylinder is set at a right angle, the seed and juice falling into a receptacle below and the coarse pulp passing on through the end of the revolving cylinder.



Arbogast Seed Farm, Michigan

The grower of certified seed should own a threshing machine in order to prevent the mixing of seed with the neighbor's crop.

Hand separators are used in threshing seed-crops of broom corn, fiber flax, and beets. Lettuce, onion, and carrot seed are threshed by hand with flails. The seeds of pumpkins and squashes, after the fruits are cut open with a dull knife or cleaver, are scooped out with a large spoon.

The seed of certain of the pulpy fruits is encased in a pulpy sack difficult to remove by washing. Cucumber, muskmelon, watermelon, and tomato seeds are generally fermented for several days after screening and then washed and cleaned. Squash seed, however, must not be fermented because the seed coat is corky and easily dissolved.

The seed grower should own all necessary seed-threshing or

separating machinery and keep it on the farm. If an itinerant thresher is used, the ledges, corners, and screens should be carefully cleaned to prevent mixing seed.

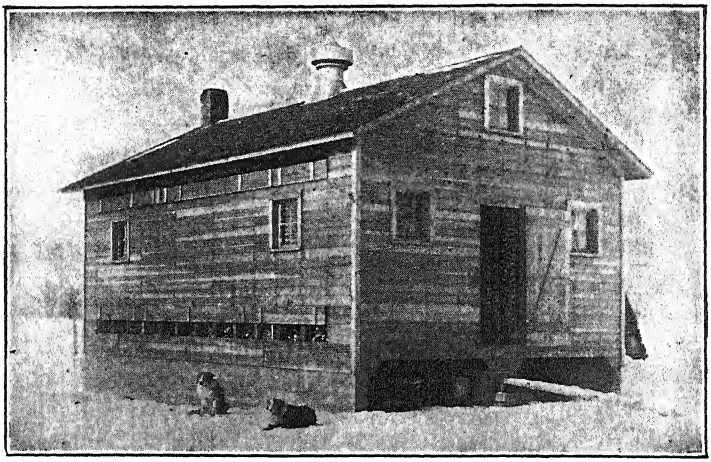
Seed Must Be Cured Thoroughly. Dryness is essential in maintaining the vitality and appearance of seed. Molds develop under damp storage conditions, seed quality depreciates, and vitality is impaired. The germination of seed carrying excessive moisture, 15 per cent or more, is seriously damaged by freezing, but dry seed will stand freezing with little impairment. Seed not properly dried will often heat in bins or sacks, and its vitality will be greatly reduced. It is, therefore, important that proper equipment be available for curing and storing. Sweet corn and field corn should be dried on the ear in well-ventilated cribs or in the seed house. In northern states, many seed-corn growers hang the ears on wire hangers or place seed ears in shallow trays with slatted or wire-meshed bottoms, using artificial heat to insure drying. Seed of pulp fruits is dried on cloth-covered racks in the sun or by steam driers. The seed of beets, lettuce, cabbage, and other garden seeds are usually dried in the sun under western irrigated conditions or are spread thinly on canvas sheets on the barn floor under humid conditions.

Seed for Marketing Must Be Cleaned with a Good Fanning Mill. A good type of fanning mill, with an adequate assortment of screens, is part of the necessary equipment of the seed grower. An efficient fanning mill removes many weed seeds, light seeds, cracked seeds, dirt, and chaff. The weight per bushel, purity, and appearance are greatly improved by the use of the fanning mill. Grain as it comes from the thresher is seldom in condition for planting. By equipping the fanning mill with the proper screens, seed corn may be cleaned and graded after shelling. Seed beans and peas should be cleaned with the fanning mill and then hand-picked by the use of a special hand-picking machine.

The fanning mill removes much of the weed-seed content and the dirt found in the seed of clover, alfalfa, sweet clover,

and lespedeza, as they come from the thresher. Special machinery, not found on the average seed farm, is necessary to remove buckhorn, catchfly, Canada thistle, and many other noxious weed seeds found in the seed of these crops.

Seed Must Be Stored under Dry, Well-Ventilated Conditions. After thorough curing, seeds should be stored in a dry,



A well-ventilated seed house equipped for curing and storing seed corn and seed grain.

well-ventilated seed house or a seed room. The seed house should be constructed to exclude rats, mice, and sparrows. The floors and sides of bins should be strong and should be made mouseproof and ratproof by screen wire or tin at the corners. Bins should be made so that they will be tightly closed for carbon disulphide treatment, if this treatment is needed to control storage insects.

The seed grower will often find it advantageous to build a specially constructed seed house, connecting the fanning mill with bins by chutes, so that bins may be filled as seed is cleaned. The constructing of bins in such a way that seed may be carried by gravity and discharged through chutes into

bags or wagon beds is a great convenience. The saving of labor in a well-arranged seed house will soon pay for the cost of construction. Seed-corn growers consider a special drying and storing house an essential part of their equipment.

Bags That Are Clean, Strong, and Tagged Inside and Out Must Be Used. When seed is shipped to customers or to seed warehouses it should be placed in clean, strong bags with shipper's tag both inside the bag and, strongly attached, outside. If used bags are employed, they should be turned inside out and shaken to remove the seed left in seams which might cause mixtures. Bags should be rolled and sewed properly at the top rather than tied. Prompt attention should be given to filling orders for seed, and adequate records of all orders and shipments should be kept.

SUGGESTIONS

1. Make plans to obtain seed of improved varieties and strains for growing on home farms. Many groups of students have cooperated in obtaining improved seed, growing the crops under certain conditions, and selling much of the crop for seed purposes.

2. Investigate the possibilities of joining the state crop-improvement organizations which also furnish aid in growing and marketing certain crops for seed purposes.

3. Plan to make exhibits of samples of improved crops grown on home farms. Whenever possible compare the results obtained from the new introductions with the old crops. Have samples of each on hand and put the comparative facts in chart form. Do not exhibit from the standpoint of earning prizes but try to make educational exhibits at school and community fairs. Merchants will often be pleased to have crop exhibits put in store windows.

4. Make arrangements to give hybrid corn a trial on home farms. It may also be practical to investigate the possibilities of producing hybrid seed. Students are strongly urged to visit an experiment station where corn-breeding work is in progress.

5. Make a particular study of the weed and seed laws of your state. Procure from the state department of agriculture the publications having to do with regulation of seed trade.

6. Send samples of seed to the state seed-testing laboratory in order to become familiar with the service.

7. Visit an elevator or seed house where farm seeds are sold. Examine the various brands and look at the tags for statements about the purity and germination of the seed. Examine the machinery for cleaning seed.

8. Examine samples of seed in the classroom for the presence of weed seeds and trash. Make a test of the germinating ability of the seed by testing samples of one hundred seeds.

9. If arrangements are made for a number of students to grow improved crops, articles for the local papers should be prepared from time to time to tell of the progress being made. Such articles may be prepared by the students in agriculture. Often the aid of the high-school teacher of English may be enlisted.

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CHAPTER XI

GROWING CROPS IN ROTATION

A field is not sown entirely for the crop which is to be obtained the same year, but partly for the effect to be produced in the following.
VARRO

When a succession of different crops is grown on the same soil crop rotation is being practiced. The practice of growing the same crop upon land year after year is fast changing to the practice of growing crops in rotation.

Farmers find many advantages in rotating their crops, and experiment stations have facts to show that it is usually much more profitable to rotate crops than to use the land year after year for the same crop.

Growing crops in rotation is concerned with:

1. Advantages of using crop rotations.
2. Effect of rotations on crop yields and soil conditions.
3. Planning field arrangements for rotations.
4. Planning rotations and systems of fertilization.
5. Some typical rotations.

Advantages of Using Crop Rotations. The practice of growing crops in rotation distributes the demand for labor throughout the season; reduces the cost of production because one crop often prepares the way for another crop; aids in the control of weeds, plant diseases, and insect pests; reduces risk by diversifying the crops produced on the farm; provides hay, pasture, and grain feed needed for livestock feeding; provides proper conditions for cash crops; and aids in the maintenance of organic matter and nitrogen by the inclusion of leguminous crops.

Effect of Rotations on Crop Yields and Soil Conditions. Information from the Ohio Agricultural Experiment Station in Table 10 indicates that yields are much larger when corn is grown in a rotation than when corn is grown continuously.

TABLE 10

TWELVE-YEAR (1922–1933) YIELDS PER ACRE OF CORN GROWN CONTINUOUSLY AS COMPARED TO CORN GROWN IN ROTATION ON LAND GIVEN THE SAME MANURE AND FERTILIZER TREATMENT *

	Average Yield of Corn, Bushels
Corn, continuous	25.8
2-year rotations	
Corn, oats (sweet clover)	64.3
Corn, wheat (sweet clover)	61.7
3-year rotations	
Corn, wheat, red clover	66.3
Corn, oats, red clover	70.3
4-year rotations	
Corn, oats, wheat, red clover	65.1
Corn, corn, wheat, red clover	65.1–53.6
5-year rotations	
Corn, oats, wheat, red clover (timothy), timothy	69.8
Corn, corn, wheat, red clover (timothy), timothy	72.1–61.5

* "Handbook of Experiments in Agronomy," *Ohio Agricultural Experiment Station, Circular* 46, June, 1935, pp. 91–94.

The famous long-time rotation and fertilizer experimental plats on the fertile prairie soils of the Illinois Experiment Station, reported in Table 11, show that in the 48 years from 1888 to 1935 corn grown in rotation with clover and oats produced nearly double the yield of corn grown continuously.

In experiments at Bethany, Missouri, as shown in the diagram on page 185, crop-rotation systems reduce greatly the loss of soil from fields as compared with the great losses from fields devoted to the continuous growing of corn.

At the Kansas Agricultural Experiment Station a crop ro-

TABLE 11

CROP YIELDS FROM ILLINOIS EXPERIMENT FIELDS *

(Average Annual Crop Yields in Bushels or (Tons) per Acre)

Treatments	Continuous	Rotations				
		Corn, oats		Corn, oats, red clover		
	Corn	Corn	Oats	Corn	Oats	Hay
1888–1935—48 years						
None	29.6	36.3	36.0	46.3	48.4	(1.67)
1906–1935—30 years						
None	24.5	33.7	33.0	45.6	48.7	(1.25)
MLP	40.8	58.3	58.1	64.5	67.5	(2.67)
1924–1935—12 years						
None	22.9	28.9	30.0	36.2	54.7	(1.27)
MLP	42.0	53.0	62.9	58.9	81.4	(3.12)

* *University of Illinois Agricultural Experiment Station, Bulletin* 425, July, 1936.

tation of alfalfa, corn, and wheat shows an increase, for an average of 20 years, of 14.2 bushels of rotated corn over continuous corn, 5.8 bushels of rotated wheat over continuous wheat, and 2110 pounds of rotated alfalfa over continuous alfalfa.

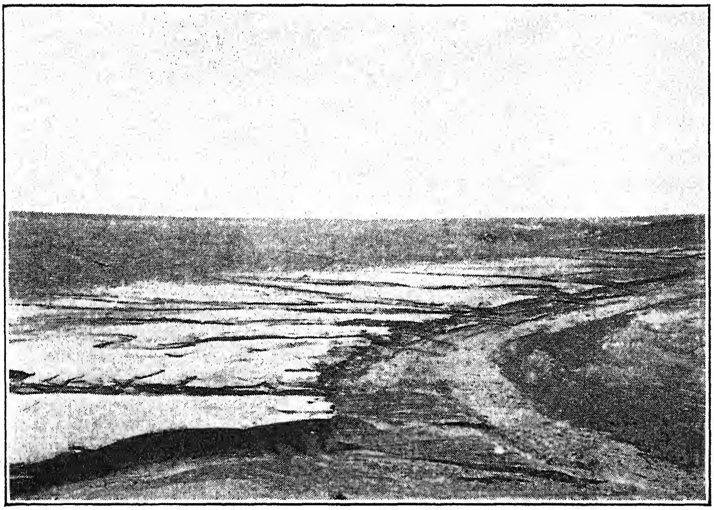
The relative value of timothy, soybeans, red clover, alfalfa, and sweet clover, when used in similar cropping systems and measured by succeeding corn crops, is illustrated in three-year average corn yields from the Mt. Morris and Dixon, Illinois, Soil Experiment Fields as illustrated in Table 12. Timothy, a non-legume, is inferior to the legumes. Soybean, a shallow-rooting legume, is inferior to the deep-rooting legumes like alfalfa and sweet clover.

TABLE 12

IMPROVEMENT IN CORN YIELDS THROUGH THE GROWING OF DEEP-ROOTING LEGUMES *

Rotations	Corn per Acre, Bushels
At Mt. Morris, Ill.	
Corn, oats, wheat, timothy	52
Corn, oats, wheat, soybeans	65
Corn, oats, wheat, red clover	70
Corn, oats, wheat, alfalfa	75
At Dixon, Ill.	
Corn, oats, wheat (straw returned)	56
Corn, oats, wheat, sweet clover, green manure	73
Corn, oats, wheat, sweet clover, green manure, and straw	82

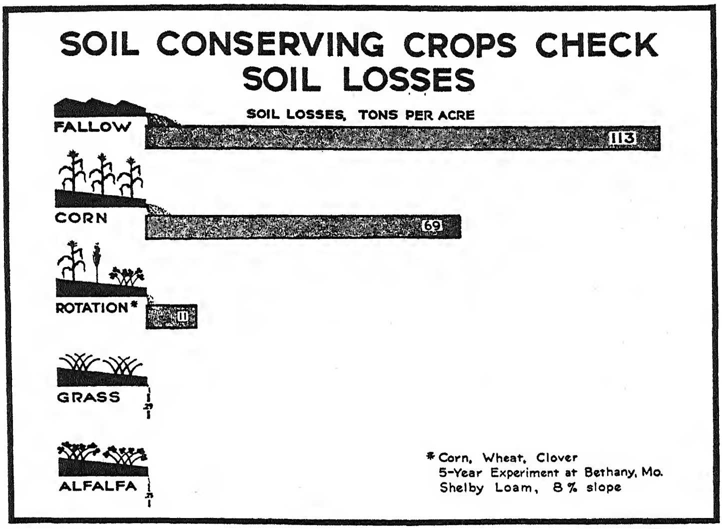
* "A Year's Progress in Solving Farm Problems of Illinois, 1933–1934," *University of Illinois Agricultural Experiment Station.*



U.S.D.A., S.C.S.

Sheet erosion takes place on soils of even moderate slope and causes great loss when land is over-cropped with cultivated crops. Rotation with legumes and grasses, strip cropping, and plowing with the contours lessen surface washing.

Planning Field Arrangements for Rotations. In planning a rotation, best results are obtained by arranging for fields as nearly equal in size as possible. Rectangular fields are usually worked most economically. Comparatively large fields reduce the cost of crop production, since they are better



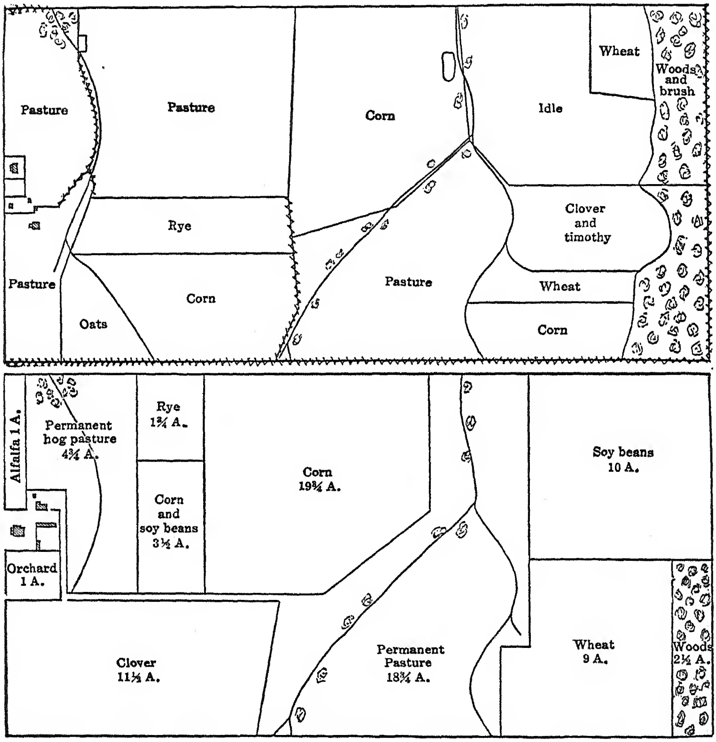
S.C.S.

Erosion losses are much greater from fallow land and cultivated land. Legumes and grasses, and growing crops in rotation, check erosion losses.

adapted to modern machinery; in larger fields much time is saved in the reduction of turns at the ends of the rows, as compared to the same area in smaller fields. As nearly as possible, the fields used in any particular rotation system should be similar in general soil characteristics and topography.

The great majority of farms can be placed on a more efficient basis by a careful revision of field and rotation plans. Fences and hedgerows that are no longer needed can often be removed to advantage. Fences occupy valuable land and are costly to maintain. Often two or more small fields can be

thrown into one by the removal of a few fences or hedges and time and labor needed for land preparation and cultural operations are saved. Brushy fields and stump lands can be cleared,



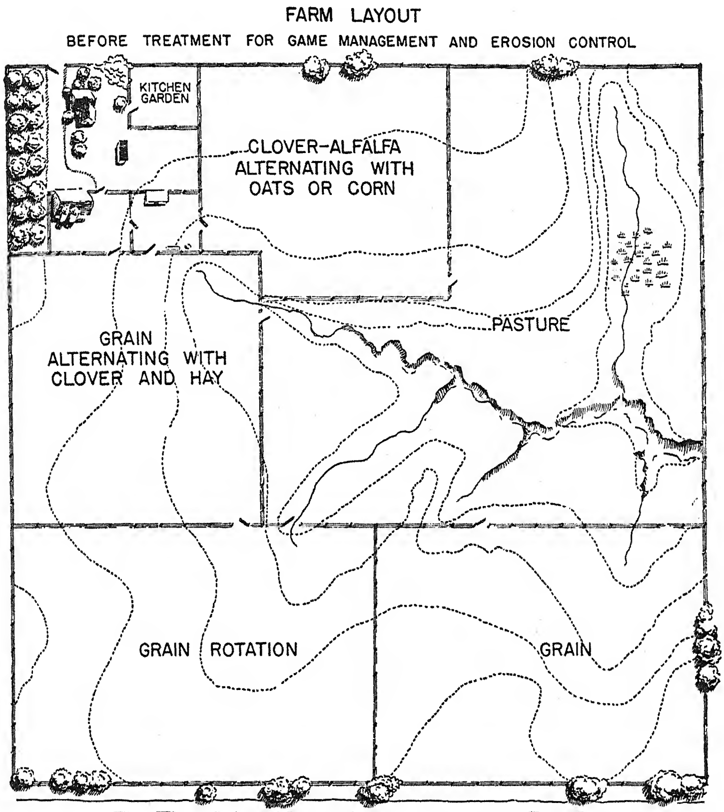
Purdue University

Replanning fields on many farms improves rotation practice, produces better-balanced livestock rations, and cheapens production costs. The above shows the "International Farm" before and after replanning under the direction of Purdue University.

poorly drained land ditched and tiled, so that such areas may be available for inclusion in the regular farm rotations.

One of the best methods to learn how to plan successful rotations is to study the rotation systems used by successful

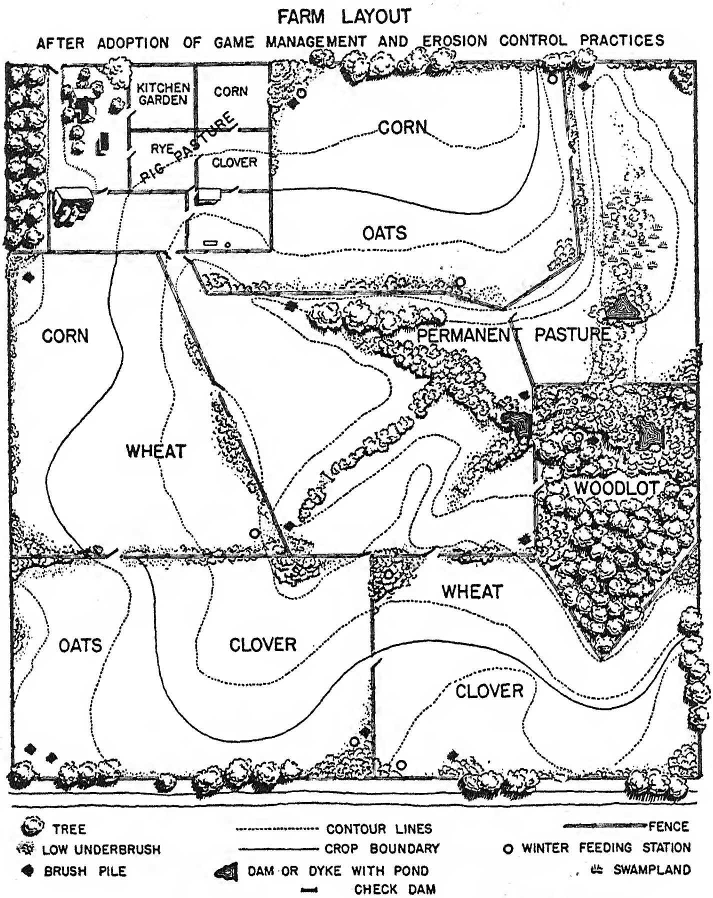
farmers. Maps of home farms as they are should be prepared and then maps to show the adjustments or changes which



U.S.D.A., Farmers' Bulletin No. 1759

More efficient cropping and livestock production, erosion control, and game management for those interested, are closely associated. Compare with sketch on following page.

may be made in improving the rotation system. Rotations should be planned for a number of years ahead to see if the plans will result in the desired program of crop production.



U.S.D.A., Farmers' Bulletin No. 1759

This farm replanned for game management is also on a better basis for efficient crop production and soil conservation. Compare with sketch on preceding page.

Planning Rotations and Systems of Fertilization. The maintenance of soil fertility is assured by growing crops in a carefully planned rotation, in the course of which proper applications of manure, mineral fertilizers, and lime are adminis-

tered. The rotation should include clover, alfalfa, sweet clover, or other leguminous crops with sufficient frequency to maintain nitrogen and organic matter in the soil. Manure, straw, and other crop residues produced on the farm should be returned to the land, usually being applied on clover or other sod crops preceding corn.

When lime is needed to correct soil acidity, a sufficient amount should be applied. On the majority of farms the use of 500 to 800 pounds of acid phosphate or from 1500 to 2000 pounds of ground, raw rock phosphate, applied during four years, will maintain the phosphorus content. The phosphate is usually applied at the time of seeding grain crops or is broadcast on meadows. Average soils are apparently well supplied with potash and, if the content of organic matter is maintained, potash is made available. Much nitrogen can be obtained from the air by the growing of leguminous plants.

For the average crop farmer, a simple plan for maintaining the calcium carbonate (lime), nitrogen, and phosphorus content of the soil consists of a proper rotation, the use of ground limestone, and the application of acid phosphate and manure. On farms where manure is not produced in sufficient amounts, and where potash as well as phosphorus is deficient in the soil, sufficient application of complete fertilizers is essential to place fertility maintenance on a basis of permanency and profit. If land needs tile drainage, proper tiling must be considered the first step in its improvement.

Some Typical Rotations

Rotations for Sandy Loams

A. (1) Potatoes or corn; (2) rye seeded to clover or sweet clover; (3) clover or sweet clover for hay, pasture, seed, or turning under.

B. (1) Potatoes or corn; (2) rye and vetch; (3) soybeans; (4) buckwheat or oats, seeded; (5) clover or sweet clover.

C. (1) Potatoes, corn, or beans; (2) light seeding of rye or buckwheat seeded to alfalfa; (3) alfalfa; (4) alfalfa; (5) alfalfa.

Rotations for Loams and Silt Loams

A. (1) Corn, beans, or beets; (2) oats or barley; (3) wheat or rye seeded to clover or sweet clover; (4) clover or sweet clover.

B. (1) Corn, beans, beets, or potatoes; (2) oats or barley seeded to clover; (3) clover; (4) beans, beets, potatoes, or corn; (5) oats or barley, wheat or rye (seeded); (6) clover.

U.S.D.A. Resettlement Administration

Uncontrolled floods cause great damage to farmers in the bottomlands. Sound rotation practices and the covering of steep slopes with trees and grass in the upper reaches of the watershed aid in preventing serious flood damage.

C. (1) Corn or beans; (2) corn, beans or beets; (3) oats, barley, wheat, or rye, seeded to alfalfa; (4) alfalfa; (5) alfalfa; (6) alfalfa.

D. (1) Corn, beans, beets or potatoes; (2) oats or barley; (3) wheat or rye, seeded to clover and timothy; (4) clover and timothy; (5) timothy.

Rotations for Clay Soils

A. (1) Corn; (2) oats and barley; (3) wheat or rye, seeded to red and alsike clover and timothy and June grass; (4) clover and timothy; (5) timothy and alsike; (6) pasture; (7) pasture.

B. (1) Corn; (2) oats or barley; (3) wheat or rye seeded to clover or sweet clover; (4) clover or sweet clover.

C. (1) Cultivated crop; (2) small grain (seeded); (3) clover and timothy hay; (4) timothy hay; (5) pasture.

SUGGESTIONS

1. List on the blackboard the rotations in common use on home farms together with the rotations used by certain farmers who have been particularly successful in maintaining the productivity of their soils. With each rotation system include the practices followed in the use of manure and fertilizers. Use the information as a basis for discussing such topics as: a comparison of a crop-rotation system and continuous cropping; the relationship between crop-rotation systems and the type of farming being followed; the comparative advantages of using different crops in the rotation system; the order of growing crops in the rotation; the use of manure, lime, fertilizers, cover, and green-manuring crops in the plan of crop rotation.

2. Plan improvements in the rotations used on home farms or in the rotation for a particular farm being studied. In planning for such improvements it is well to prepare maps of farms showing field arrangement, fence lines, lanes, streams, woodlots, orchards, gardens, homesteads, and buildings. If major changes are needed in field arrangements, draw new maps to indicate the changes. Arrange the yearly cropping plans for a number of years ahead to test the probable efficiency of the system of rotation.

3. In regions where soil erosion is a major problem, visit farms where rotations are being used in connection with strip cropping and terracing. Investigate the methods used for producing crops in a manner that will prevent erosion.

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CHAPTER XII

PREPARING SEED BEDS; PLANTING AND CULTIVATING CROPS

He that by the plow must thrive
Himself must either hold or drive
BENJAMIN FRANKLIN

Much of the success in growing crops depends upon preparing the kind of seed bed which will give the crop the right start, planting the seed correctly, and cultivating those crops that need it after coming up. All the operations must be done with care; otherwise what is gained by being efficient in one operation may be lost by carelessness in another.

The following operations should be considered in preparing seed beds, planting, and cultivating crops.

1. Planning for satisfactory seed beds.
2. Plowing the seed bed.
3. Disking, harrowing, compacting the seed bed.
4. Controlling weeds by good seed-bed preparation.
5. Preparing seed beds for small grain.
6. Planting crops.
7. Cultivating to control weeds and conserve moisture.
8. Using special practices in seed-bed preparation.

Planning for Satisfactory Seed Beds. A good seed bed must provide the best possible conditions for the germination of seed. The ground must be compact enough so that capillary moisture will come in contact with the seed. The ground must be loose enough to allow air to penetrate into the soil to supply oxygen to the germinating seed. In addition, the entrance of air helps to warm the soil; thus the proper temperature conditions for the germination of seed are provided.

The soil should be worked under good conditions so that large hard clods will not be formed. Clods interfere with the work of seeding machinery and provide poor conditions for the germination of seed. The remains of crops such as corn must be plowed under or worked down well enough to prevent such material from interfering with seeding operations.

Seed beds should be prepared whenever possible in such a manner as to destroy weeds. Sometimes it is advisable to put seed beds in such condition that weed seeds will germinate and start their growth. Additional working of the seed bed before the crop is planted will kill an enormous number of weeds. Good rotations plus proper working and cultivating of the soil will do much to control weeds.

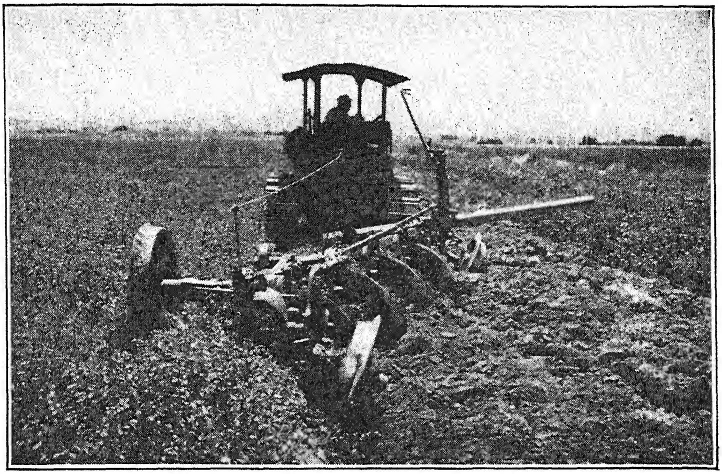
In summary, it may be said that a good seed bed is compact enough to bring moisture to the seed for germination, open enough to provide for the entrance of air, worked well enough to provide good operating conditions for seeding machinery, and managed in a manner to destroy the maximum number of weeds.

Before the actual preparation of the seed bed is begun it is often necessary to fill in any gullies which have started to form, remove any rocks which may interfere with the operations, and perhaps remove stumps. It is good practice to see that fields are in condition for the first operations of plowing or disking. If strip farming, contour plowing, or terracing is to be considered, plans should be made before plowing is started.

Plowing the Seed Bed. The methods of preparing seed beds vary according to the type of soil, its topography, the crop for which the seed bed is being prepared, and the previous crop on the land. If a soil is rather compact, in sod, or has much plant growth on it, the land is usually plowed for such intertilled crops as corn, potatoes, or cotton.

On heavy land, such as clays and heavy loams, plows equipped with chilled-steel moldboards, of the long, sloping type, are necessary. The same type of plow is used in turning

sod land. Loams and sandy loams can best be plowed with a broader moldboard, having less slope and a steeper angle. For good work in turning sods on heavy lands, the plow should be equipped with both the jointer and the coulter. Care should be taken to have the jointer and coulter properly adjusted and the plow point set at the right depth and in proper align-



U.S.D.A. Extension Service

Plowing green manure into the ground where potatoes are to be planted.

ment. The plow should be kept well sharpened to reduce the draft and to turn a good furrow. Plowing costs are reduced and a better job performed by plows of the broad-bottom type with 14-, 16-, or 18-inch bottoms. Where large acreages are plowed, tractor power enables one man to operate two or more plowshares at one operation.

In order to do a good job of plowing, the soil should be plowed when it is in the right condition. If it is plowed when too wet, a cloddy seed bed, which is hard to work, results. Plowing soils when too dry, particularly heavy soils, greatly increases the work of plowing and also results in a cloddy seed bed difficult to reduce to a good condition of tilth.

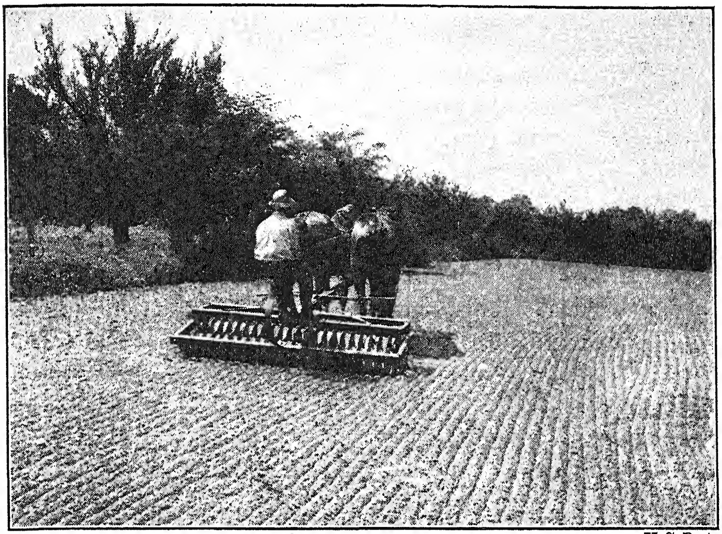
Soils are in best condition for plowing when still moist enough to be molded in the hand, but sufficiently free of excess moisture to crumble easily when the molded ball is struck. When land is plowed in this condition, the draft is at the minimum, and the furrow turns over in a crumbled condition. It is then readily reduced to a fine state of tilth by the use of disk, harrow, or cultipacker.

Fall plowing is particularly effective in the preparation of average soils for corn, potatoes, beans, or other cultivated crops. For these crops, the soil should be plowed to a depth of approximately 7 inches and allowed to go through the winter in the rough. Usually, clover, alfalfa, or pasture sods are turned under for corn. By plowing in the fall, ample time is offered for the incorporation with the soil of crop residues and manure; the lower part of the furrow slice becomes well settled; the moisture-holding capacity of the soil is increased; soil insects, such as cutworms and white grubs, are largely controlled; the germination of many weed seeds in the soil is destroyed by winter weather conditions. Some soils, notably very light sandy soils and extremely heavy clay lands which tend to pack, are not benefited by fall plowing.

If fall plowing is not practiced, early spring plowing for cultivated crops gives good results. When land is plowed in early spring, sufficient time is allowed for the settling of the seed bed. It is advisable in this season to plow less deeply. The plowing should be succeeded by the use of the cultipacker or roller, and the soil should be disked or harrowed with a spring-tooth or spike-tooth harrow at intervals of a week or ten days until planting time.

Disking, Harrowing, Compacting the Seed Bed. When weather or labor conditions do not permit either fall or early spring plowing, and it is necessary to prepare the seed bed just before planting time, the plowing should be followed immediately by the use of a weighted roller or cultipacker, the field being rolled several times if necessary to insure the compacting of the furrow slice, the breaking of clods, and the

closing of air chambers in the lower part of the furrow slice. If the soil is cloddy or if a crust forms, the disk harrow is most effective in improving its condition. The cultipacker, bar roller, and spring-tooth harrow are effective implements for the final preparation of the seed bed before planting.



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A good seed bed, well firmed in the lower part of the furrow slice and with surface in fine condition of tilth.

The seed of corn, beans, sugar beets, and potatoes starts best on seed beds plowed to a good depth, with the lower part of the furrow slice throughly settled and the surface reduced to a fine condition of tilth.

Controlling Weeds by Good Seed-Bed Preparation. Attention to the thorough fitting of the seed bed will reduce, by as much as one-third to one-half, the labor necessary for the cultivation of intertilled crops after the crop is planted. A much larger acreage can be covered in a day with the disk, spike-tooth, or spring-tooth harrow than with the cultivator. Weeds

are most effectively killed by disking or harrowing when fitting the seed bed, since at that time weed seeds are just germinating or the plants are very small and easily killed by cultivation. Extra work in seed-bed fitting generally lessens the later expense of cultivation.

Preparing Seed Beds for the Small Grains. Under average conditions, wheat, rye, oats, and barley grow best on land plowed to a medium depth (5 or 6 inches), thoroughly settled, and well surfaced. In common rotations in northern states, wheat often follows oats. Best results are secured if the oat stubble is plowed as soon as possible after the oats are removed, rolled with a cultipacker or roller, and disked or harrowed at intervals of a week or ten days until planting time.

In Corn Belt states, where wheat usually follows corn, thorough disking is usually the most economical method of preparing the seed bed. In northern rye-growing states, rye is frequently planted after silage corn or beans, and occasionally after sugar beets or potatoes. A thorough disking prepares such land most economically for rye. If wheat or rye follows oats, the early plowing of the oats stubble will result in a better settling of the seed bed.

Spring-planted small grains, such as oats, barley, and spring wheat, should be planted on firmly settled, well-worked seed beds. Land which was in a cultivated crop, such as corn, potatoes, or beans, the previous year, can be prepared effectively by disking in the spring. Weedy ground or sod land to be planted to these crops should be plowed in the fall, or as early as possible in the spring, after the seed bed has been prepared by the cultipacker, roller, and harrow.

Planting Crops. The methods used in planting various crops vary to a great extent but certain principles apply generally. The experience of successful farmers in the community and publications from experiment stations and agricultural extension services may aid in the selection of good practices.

Care needs to be taken to plant crops at the correct time. Crop seeds that need a warm soil in which to germinate often rot when planted too early. Certain crops should not be planted late because the growing season after a late planting may not be long enough to permit the crop to mature. Table 13 presents the relationship between the date of planting and the yield for oats, barley, and spring wheat.

TABLE 13

Two-Year Average Yields Obtained with Different Seeding Dates at the Ashland Station, Wisconsin, 1933–1934 *

Crop	Time of Seeding		
	April 27, bushels	May 4, bushels	May 11, bushels
Oats	64.4	51.4	36.4
Barley	45.3	38.2	28.8
Wheat (spring)	21.7	17.7	11.0

* Annual Report of the Director, 1933–1934, *Agricultural Experiment Station, University of Wisconsin, Madison, Wis., Bul.* 430.

High-quality seed should always be used for planting because much of the prospect for a good crop depends upon the quality of seed. Rates of planting should be studied carefully in order to decide upon the amount of seed needed to insure a good stand.

The planting machinery must be tested thoroughly to be sure that it is operating correctly. The right amount of seed must be properly placed by the planting machinery. If it is recommended that seed be planted at a certain depth and covered in a certain manner, some time should be spent in testing the operating efficiency of the planter.

Table 14 gives some interesting information on the relationship between yields of corn and the thickness of stand. It will be noted that the better the condition of the soil, the greater is the importance of having a stand thick enough to make possible higher yields.

TABLE 14

CORN YIELDS AS RELATED TO THICKNESS OF STAND *

Care of Soil †	Average Number of Stalks per Hill ‡	Number of Fields	Five-Year Average Yield per Acre, Bushels
Well-treated	1¼ to 1¾	58	43.3
	1¾ to 2¼	408	49.5
	2¼ to 2¾	339	54.1
	2¾ to 3¼	66	61.0
Fairly well-treated	1¼ to 1¾	122	42.2
	1¾ to 2¼	754	46.3
	2¼ to 2¾	493	50.6
	2¾ to 3¼	90	50.8
Poorly treated	1¼ to 1¾	89	37.9
	1¾ to 2¼	583	41.9
	2¼ to 2¾	236	42.9
	2¾ to 3¼	36	46.2

* H. C. M. Case and M. L. Mosher, "Farm Practices That Pay," *Illinois College of Agriculture and Experiment Station Circular* 389.

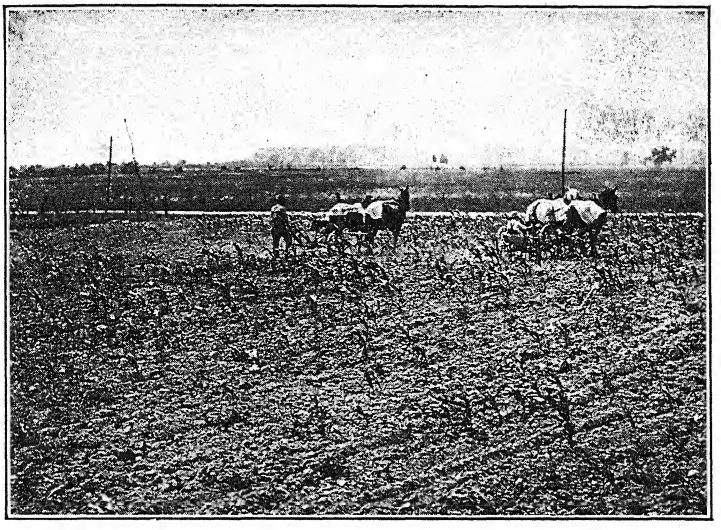
† "Well-treated soils" had been well treated with clovers, manure, limestone, and phosphate. "Fairly well-treated soils" had had some clover, manure, limestone, or phosphate but not enough to place them in a high-yielding class. "Poorly treated soils" had had little or no treatment with clover, manure, limestone, or phosphate.

‡ Each cooperator was asked to estimate the average number of stalks per hill after the first or second cultivation.

If fertilizer attachments to the planting machines are used, it is essential to see that they are putting on the right amounts of fertilizer and placing the fertilizer correctly in relation to the seed. Stands of corn, for instance, may be thinned or weakened by the improper placement of fertilizer.

An excellent job of planting means that the right amount of

high-quality seed has been placed in the soil under conditions which are favorable to the germination of the seed and the growth of the plants. A stand containing the right number of vigorous plants ready to make the most of a growing season should result.



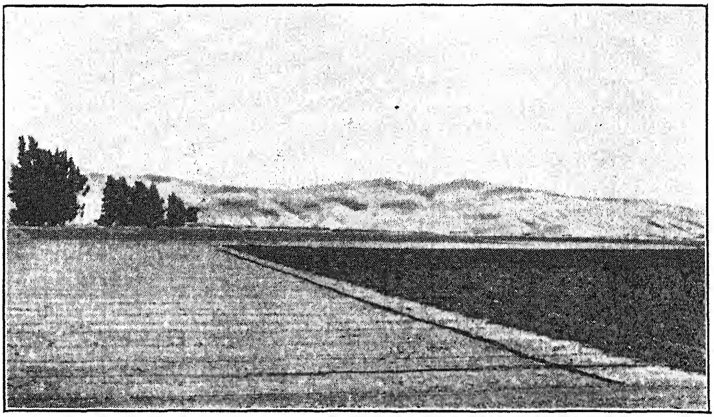
Poorly prepared seed beds, poor drainage, insect injury, or poor seed may be responsible for a poor stand of corn.

Cultivating to Control Weeds and Conserve Moisture. The most important reason for cultivating crops is to destroy weeds which compete with crops. Weeds rob crop plants of plant food, moisture, and air. In many instances the presence of weeds in the harvested crops tends to lower the value of crops and sometimes even destroys their sale value. Cultivation is one means of doing away with troublesome weeds.

Certain types of soils tend to form a crust after rains. Such soil crusts prevent air from entering the soil and interfere with germination and root growth. A heavy crust also prevents seedlings from pushing their way through the soil. Cul-

tivation keeps the surface of the soil in a loose condition. A loose layer of soil or mulch prevents capillary moisture from rising to the surface and its consequent loss from evaporation.

One of the best methods of cultivating to prevent weed growth is to prepare seed beds some time before they are needed for the crop. The early working of the soil starts the



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A well-prepared seed bed ready for planting sugar beet seed in an irrigated California valley.

growth of weeds. As a result of disking or harrowing to put the seed bed in final shape, great numbers of weeds are destroyed.

Often weeds start between the time a crop is planted and the time it is up. It is an excellent plan to go over the land with a spike-tooth harrow or weeder before the crop comes up. Such cultivations not only destroy weeds but also tend to eliminate a crusty or baked condition of the soil. With a crop such as corn, the spike-tooth harrow may be used until the corn is several inches high; the rotary hoe may be used until the corn is about a foot in height.

While crops are rather small it is possible to set cultivator

shovels to run rather deep. After the plants have much growth the cultivations should be very shallow in order not to cut off many of the roots. By the time corn planted under ordinary conditions is 15 inches high, the roots have spread throughout the soil between the rows. If cultivator shovels are set deep, many valuable feeder roots are destroyed. A good rule to follow under most conditions is to cultivate just enough to keep weeds under control.

Table 15 indicates the effect of different methods of cultivation on the yield of corn. The importance of controlling weeds is emphasized.

TABLE 15

EFFECT OF DIFFERENT METHODS OF CULTIVATION ON CORN YIELDS *

(Average for six years)

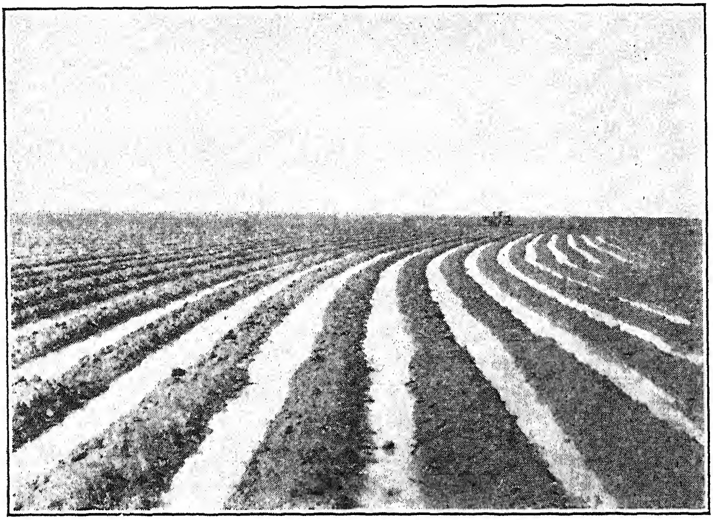
Kind of Cultivation	Yield Average of Six Years, Bushels
Weeds allowed to grow	7.0
Weeds scraped with hoe	53.3
Cultivated (blades)	53.0
Cultivated (shovels)	51.1

* D. C. Wimer and M. B. Harland, "The Cultivation of Corn," *Illinois Agricultural Experiment Station, Bul.* 259, p. 193.

Using Special Practices in Seed-Bed Preparation. When particular conditions of rainfall and topography are present, certain practices in seed-bed preparation that are particularly adapted to the situation must be employed.

Fallowing Land. In regions of low rainfall where irrigation is not practiced, land is fallowed one season and cropped the next. Fallowing consists in cultivating the soil often enough to prevent any plant growth and to keep the surface of the soil covered with a loose layer of soil which acts as a mulch. By preventing plant growth and as much evaporation as possible, moisture is stored for the use of crops grown in alternate years. Such fallowed land is often left ridged or furrowed during the winter in order to hold snow and moisture.

Listing Soil. Seed beds are sometimes prepared with the use of listers. A lister is a machine with a double moldboard which throws the soil to either side and leaves a furrow in the center. When soil is single-listed, the ground underneath the ridges is unstirred. Double listing after single listing splits the ridges.



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Plow furrows following the contour hold water and prevent run-off.

The practice of listing is quite largely confined to rather dry regions. Depending upon the crop and the conditions, seed may be planted in the furrows or on the ridges. When listing is done in the fall, it should be at right angles to the prevailing winter and spring winds in order to catch snow and prevent the soil from drifting.

Strip-Cropping. Strip-cropping is the practice of growing crops in narrow strips which follow the contour of the land. Cultivated crops are alternated with sod or small-grain crops. Such a system prevents erosion because the water does not

have much opportunity to wash in the narrow strips devoted to crops which are cultivated. The sod strips tend to catch whatever soil may be washed from the cultivated strips. A further advantage is that there is very little up-hill and down-hill driving in seed-bed preparation, planting, and cultivating.

Terracing. Terracing is a system of preparing broad ridges of soil across the slope of the land. The terraces follow the contour of the land so that surface water may be carried away along a slight grade leading to an outlet. The distance between ridges or terraces depends upon the slope. The greater the slope, the shorter the distance between the terraces. Terracing prevents run-off water from washing away the soil because the water has little opportunity to travel at a rapid rate.

Plowing and other seed-bed operations, planting, and cultivation follow the terraces across the slopes.

SUGGESTIONS

1. What are the specific problems in seed-bed preparation, planting, and cultivating found on home farms? Such problems may be presented for discussion with consideration of a definite series of steps such as:

   a. Crop to be grown. Consider the important crops in a given situation.
   b. Type of soil on which the crop is to be grown.
   c. Previous crop on the soil and previous treatment of soil.
   d. Procedure to follow in preparation of seed bed. Try to give attention to a definite situation and be specific in deciding upon practices to follow. Bring into the discussion all the particular problems which have occurred or are likely to occur. Weed problems, soil conditions, slope of land, available labor, equipment, time, and other such factors should be considered.
   e. Planting. Enumerate the specific practices which apply to the important crops. The time, rate, and method of planting may be considered.
   f. Care of crops from planting to harvest. For each of the important crops grown on home farms enumerate the important practices to follow and give attention to the problems which are present.

The outcome of such a discussion may be organized by preparing on the blackboard a large table with points *a* to *f*, inclusive, as the horizontal headings and with the specific crops as the left-hand column. The development of such a table will cause students to give definite consideration to the facts involved.

2. Whenever possible, careful observation should be made of seed-bed preparation, planting, and cultivating. Accurate observations must be made as a basis for adjusting procedures to meet the problems which arise.

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CHAPTER XIII

HARVESTING AND STORING CROPS

Efficiency in harvesting and storing crops depends upon securing the greatest possible quantity and the highest possible quality within practical cost limits. Certain important factors must be considered in the harvesting and storing of crops. There are principles to be applied. An understanding of the factors and principles is essential to the solution of the problems which are certain to arise.

The factors having to do with the principles of harvesting and storing crops are:

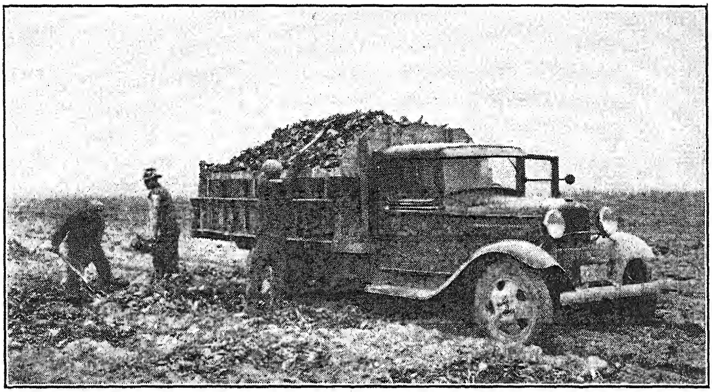
1. Timing the harvest.
2. Machinery in harvesting.
3. Moisture and temperature control in relation to harvesting and storing crops.
4. Cost of storage.

Timing the Harvest. The timing of the harvest is not merely a matter of the gathering of crops when they are ripe, but a problem to which successful farmers give much attention. The quality and quantity of the harvested crop depend to a large extent upon the proper timing of the harvest.

Farmers must select crops that will mature within the growing season. The time of harvest should occur before there is much danger of losing the crop by frost or bad weather conditions. Every year many farmers run the risk of crop loss by growing crops that are not adapted to the length of the growing season.

The time of harvesting may be influenced by the use of fertilizers. (See Table 7, Chapter VII.) Under certain soil

conditions, the date of maturity may be changed many days by the use of the right fertilizers. When fertility conditions are poor, crops tend to be slow in growth and late in maturing. Corn on poor ground is often damaged by freezing weather because of late maturity.



Michigan Agricultural Experiment Station

The use of trucks is becoming of increasing importance in hauling sugar beets to factory or loading point and other heavy products to marketing points.

In the case of small grains, particularly oats, it is important to make a careful selection of varieties and use cultural practices which will bring early maturity, since extremely hot weather is detrimental to the filling of the oat kernels. Again, it is important to time the harvest properly when small grains are used as nurse crops for seedings of such crops as alfalfa, clover, and timothy. It may be much better to cut the nurse crop at a time when it will make good hay rather than to harvest it for grain. An early removal of the nurse crop may be more profitable than later harvesting, when there is the chance of damage to the new seeding.

Pasture crops may be thought of as being harvested when they are consumed by grazing animals. Much of the success

in managing a pasture depends upon the timeliness of the grazing program. Grazing too early in the spring and too late in the fall greatly weakens the power of pasture crops to make

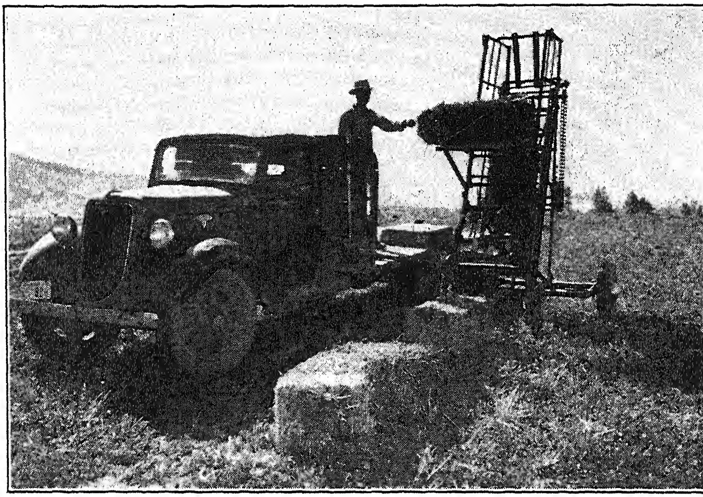
Pennsylvania State College, Agricultural Extension Service

Grazing with livestock is a cheap and effective way of harvesting forage crops and reduces the cost of producing milk and meat.

good yields, because the storage of plant food in the roots from which new growth comes is greatly depleted by such practices. Emergency pasture crops are often needed in a farming program. The timing of the periods when these crops will be ready for grazing is most important.

Often it is important to consider the time of harvest in relation to particular marketing opportunities. With potatoes

and truck crops the relation between the time at which they can be harvested and the opportunity for marketing often determines the type of crops. Early potatoes may be more profitable than late potatoes, for instance. Some farmers, for example, plan to raise a certain acreage of an especially early



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The pick-up bailer and loader greatly reduces the labor needed in harvesting and storing hay.

variety of corn to be hogged off in time to take advantage of an early fall market for pigs.

The time of harvesting crops in relation to their maturity is extremely important. The stage of maturity is related to the use to which the crop is to be put. A crop which is ripe or mature for use as feed may or may not be mature for seed purposes.

In general, grain crops which are to be used for seed purposes should be fully mature before they are harvested. The seed needs to be fully formed and fairly well dried out at the time of harvest. If harvested too early, the seed may be weak

because of underdevelopment, and it may be difficult to take care of in storage because it contains too much moisture. If it is harvested too late, there is a danger of loss from weather conditions. Certain crops tend to shatter or lose kernels when they are overripe. The time for harvesting grain crops for seed usually corresponds to the best time for harvesting for feed or for marketing.

There is, however, a great difference in the time of harvesting forage crops, dependent upon whether the crop is grown for seed purposes or for forage. When seed is harvested from forage crops, such as the clovers or timothy, the stems and leaves of the plants are little better than straw for feeding purposes. When the plants have produced mature seed, the leaves have largely dropped from the plants, and the stems are mostly woody, rather indigestible cellulose.

The time to cut forage crops for hay must be decided carefully. In general, if such crops are cut for hay rather late or when the seed is approaching maturity, the greatest tonnage is obtained. However, if the crop is cut early, the palatability and digestibility of the hay will be greater and its protein content higher, although the tonnage or yield will be less. These facts are illustrated by Table 16. It will be noted that, at Columbus, Ohio, the cuttings obtained on or about June 7

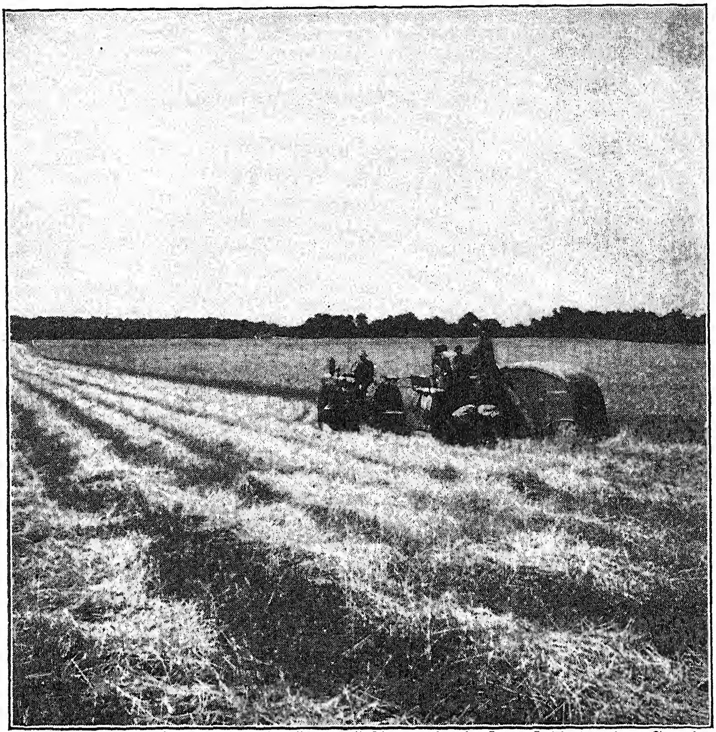
TABLE 16

RELATION OF TIME OF FIRST CUTTING OF ALFALFA TO YIELD OF HAY, PERCENTAGE OF PROTEIN, AND YIELD OF PROTEIN PER ACRE *

Date of Cutting	Yield per Acre, Pounds	Percentage of Protein	Yield of Protein per Acre, Pounds
May 31	3580	18.9	676
June 7	4060	17.4	706
June 14	4260	15.8	672
June 21	4170	14.9	622
June 28	4240	14.5	614

* R. D. Lewis, J. A. Slipher, and C. J. Willard, "Alfalfa in Ohio Farming," *Ohio State University, Agricultural College Extension Service, Bul.* 137, 1935.

yielded less total pounds per acre than later cuttings and a lower percentage of protein than an earlier cutting, but they produced the greatest yield of protein per acre.

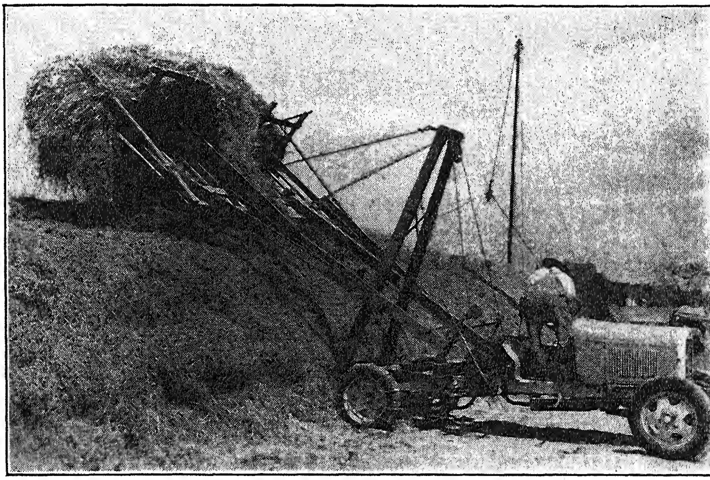


Pennsylvania State College, Agricultural Extension Service

Small combines are generally used in harvesting grains, soy beans, and legume seed-crops.

The ease of curing hay must also be considered. Early-cut hay crops contain more moisture and are therefore more difficult to cure than crops in a later stage of maturity. For crops which furnish more than one cutting, such as alfalfa, it is important to consider the effect of time of cutting upon the further growth of the crop. It has been found that, when

alfalfa is cut too early or too often, the plants tend to be weak, with a resulting decrease in the succeeding yields. Forage crops for hay should be cut at a time to secure the highest possible quality without too great a loss in yield, in ease in curing, and in weakening of succeeding growth in crops producing more than one cutting.



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The use of the buck rake increases speed of hay harvest and reduces labor.

Machinery in Harvesting. It is important to see that all machinery used in harvesting is in readiness for service during the harvest period. Delay during harvest from machinery breakdowns is very likely to be costly. The quality of the crop may be reduced because it passes the best stage for harvesting. Delay increases the risk of damage from weather conditions. The quality of the crops may be reduced because of the tendency of many grain crops to shatter if they become overripe. Delays due to machinery breakdowns may also be costly because hired help may be prevented from working efficiently.

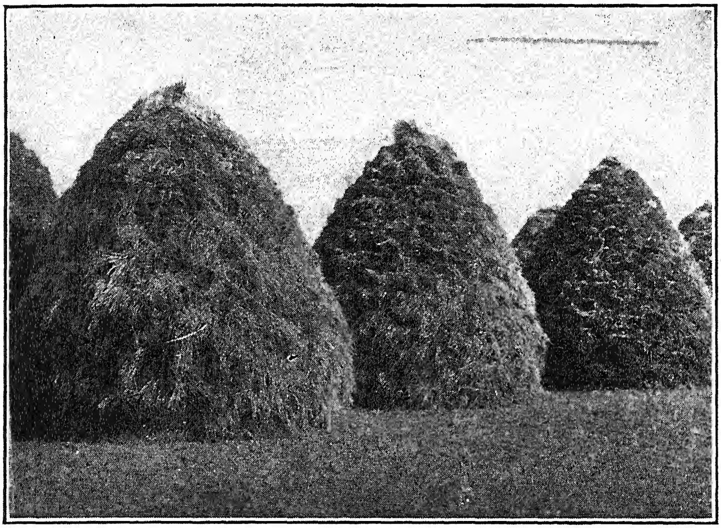
Harvesting machinery needs to be adjusted carefully to harvest the full amount of the crop and to harvest it in such a manner as to prevent injury. Potato diggers often bruise or cut the tubers unless care is taken to make the proper adjustments. Machines that are in poor adjustment may take excessive power to run. Mowers especially need attention to keep them from developing excessive side draft.

The cost of using machinery and power in the harvesting of crops must be given consideration. The costs of harvesting may be excessive if a farmer purchases a high-priced machine to harvest a small acreage. Other things being equal, the greater the acreage harvested, the smaller the cost per bushel or per unit of the crop harvested. Farmers with small acreages to harvest should seriously consider the joint ownership of expensive machinery with other farmers. When it is possible to harvest crops by hand, a farmer, before purchasing machinery, should devote time to comparing the relative costs and efficiency of harvesting by hand and with machinery.

Particular attention should be given to the operating of threshing and hulling machinery. A threshing machine in poor adjustment and operated incorrectly may not clean the grain or seed properly and may lose much of the grain in the straw. In threshing such crops as beans or peas for seed purposes, it is especially important to see that the machine does not injure the seed.

Moisture and Temperature Control in Relation to Harvesting and Storing Crops. As soon as a crop is harvested or ready for harvest, the farmer must begin an active program to prevent the crop from being destroyed by improper moisture conditions. When too much moisture is present and the temperature is well above freezing, the crop may begin to sprout. Grain often sprouts in the shock if a long period of wet weather occurs. Bacteria and molds often begin to grow, with a resulting decay or rotting of the crop. When too much moisture is present and the temperature goes below freezing, great damage is done, especially to crops intended for

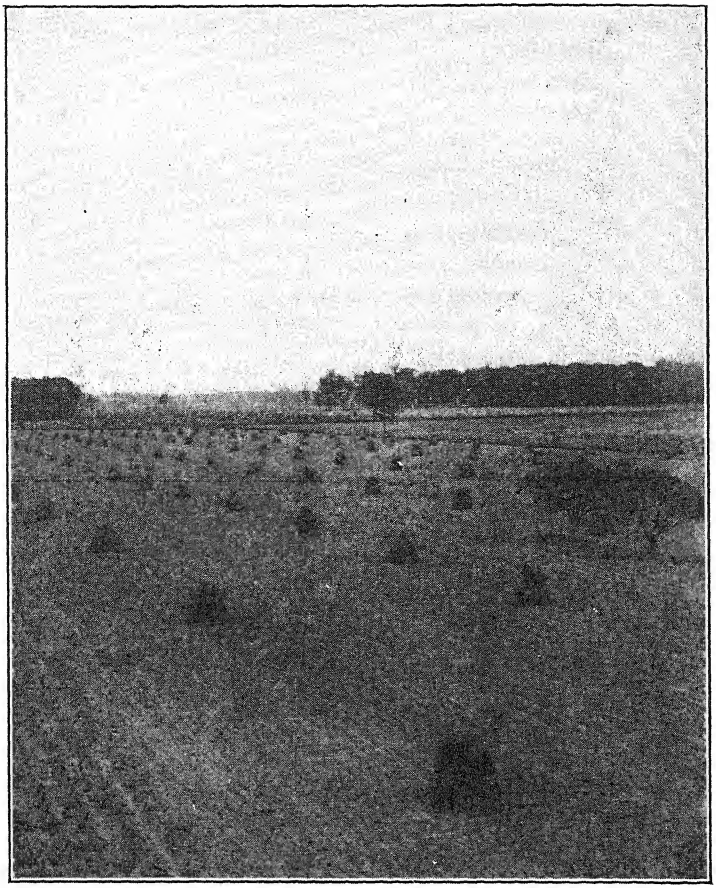
seed, because freezing injures or destroys completely the power of the seed to germinate. When crops containing too much moisture are stored in bins or mows, heating occurs which may greatly reduce the value of the crop, or even, in hay, cause fire.



Small grains should be harvested and stacked in well-made stacks to prevent discoloration and injury to germination.

The curing of crops refers largely to reducing the moisture content to a level that will permit storing the crop and keeping it in good condition. Ear corn in the fall of the year may contain from 25 to 40 per cent moisture. Such corn, to be kept in a safe condition for seed purposes, must have the water content reduced to about 12 per cent. Large producers of seed corn many times use artificial heat to dry the seed properly. Such seed is often called kiln-dried seed.

If grain goes into storage bins containing too much moisture, plans must be made to spread the grain out or move it about so that it will have a chance to dry out. A musty odor



Michigan Agricultural Experiment Station

Beans stacked around steel fence posts cure under rainy conditions that would damage a crop on the ground. (The McNaughton System.)

in grain or hay indicates that too much moisture was present at the time of storage.

Such crops as squash and pumpkins require dry-storage conditions and temperatures well above freezing.

Potatoes and root crops need storage conditions different from grain and hay in that a certain amount of moisture is needed to prevent excessive drying out and withering. A comparison of the conditions in a good root cellar with the conditions in a granary illustrates the difference. A temperature above freezing is required for the root crops and potatoes, but it must be low enough to prevent growth to any large extent.

Cost of Storage. When a farmer produces cash crops, the question often arises whether it is preferable to sell the crop at the time of harvest or to store the crop for a period of time before selling. In addition to the cost of equipment and storage facilities, the losses through shrinkage, damage from weathering, vermin, insects, and spoilage must be considered along with the costs of insurance and interest on money invested. The price at the proposed time of sale must be estimated and compared with present prices. It is often good business for farmers to cooperate in the storage of their products in order to reduce costs and spread the risks involved.

Every crop presents a particular problem. The small grains may be stored with little shrinkage but corn may lose from 15 to 20 per cent of its weight in a year's time. Potatoes shrink in storage and cannot be kept in condition longer than from one growing season to the next.

SUGGESTIONS

1. Secure from the state agricultural college the bulletins giving information about the storage of crops of particular importance in local communities.

2. Information about harvesting and storing may be summarized by preparing a table on the blackboard as follows:

Crop	Time of Harvesting	Methods of Harvesting	Storage Conditions Needed	Storage Equipment	Particular Storage Problems

3. In certain crops, where particular storage conditions are essential, it is well to plan trips for the purpose of observing equipment and procedures.

4. Make studies of the differences in prices of specified commodities at harvesting time and at later periods. Try to determine whether prices on the average tend to rise sufficiently to pay for the various costs of storing. Often such studies have been made by departments of rural economics at state colleges, and the results may be obtained.

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CHAPTER XIV

MARKETING CROPS AND COOPERATIVE PROGRAMS

The market outlet for crops is the greatest single factor in determining the choice of crops to be grown on any given farm. The efficient farmer plans to use his land, labor, and capital in a balanced program of production which will meet the market situation most effectively. Good farmers seek to dispose of the crops they produce for the highest possible money returns without depleting the soil on their farms. It is a shortsighted policy to sell crops at prices that make it impossible to replace the fertilizing elements which have been removed from the soil.

In general, crops are marketed in the form of the crop or its products; they may be disposed of as feed for livestock, when it may be said that the crop is sold in the form of livestock or livestock products. In either event it is essential to be efficient in marketing.

The essential items presented in this chapter are:

1. Essential marketing services.
2. Value of marketing services.
3. Methods of marketing.
4. Prices of farm products.
5. Federal programs for agriculture.
    a. Farmer cooperative associations stimulated by the Capper-Volstead Act.
    b. The Federal Farm Board.
    c. The Farm Credit Administration.
    d. The Agricultural Adjustment Act.
    e. The Agricultural Conservation Program.

Essential Marketing Services. In the modern commercial system of farm production and marketing there are a great number of steps or procedures which must be carried out before farm products can be delivered to the consumer. In other words, certain marketing services must be performed. These services are as follows:

Assembling. Farm products must be gathered together in sufficient quantities to make possible the performing of other services and to supply the consumer with sufficient quantity in the right form at the proper time and place.

Grading. It is very important to have farm products graded so that they may be disposed of in an efficient manner.

Packaging. Many farm products, for example, cannot be handled without being packaged in some form or other. Consumers desire to purchase commodities in convenient and attractive packages.

Processing. Few farm products are used by consumers in the form in which they were produced on the farm. Farm products must be processed or, in other words, passed through a manufacturing process to prepare them in a form desired by consumers.

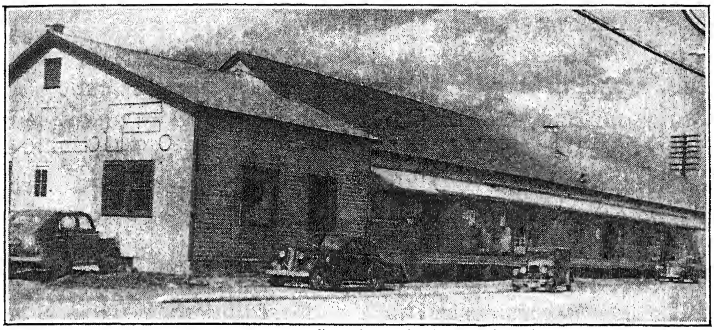
Transporting. Farm products must be transported from the farm to the market. Under modern conditions of population distribution, consumers of farm products may live at great distances from the farms on which the products are grown.

Distributing. Farm products that have been made ready for consumers must be handled so that they are convenient for the consumer to obtain. A large proportion of farm commodities must be distributed to consumers through wholesale and retail distributing units.

Financing and Insuring. Money has to be invested in farm products in order to produce and market them. A long period of time elapses before certain farm products are actually received by the ultimate consumer. Money is required to handle and hold the products during such a period. Certain invest-

ments must be made to prevent the loss of the products or to insure against loss.

Storing. Most farm products are produced during certain seasons of the year, and even those products which are produced throughout the year usually have seasons or periods of alternating high and low production. The demands for farm products by consumers extend rather uniformly throughout



Courtesy G. L. F. Service, Inc., New York

A local cooperative distributing and collecting warehouse. Seed, lime, fertilizer, feed, and other products are sold to members; grains and seed, poultry, eggs, etc., are collected for shipment to market.

the year. Storing is a very important service needed to make possible an orderly and uniform supply of farm products for the consumer.

Value of Marketing Services. Farmers should recognize that the essential marketing services must be performed if farm products are to be disposed of to consumers in an efficient manner. Middlemen performing such services in an efficient manner are doing an important type of work. They are creating worth-while values by such work. Unfortunately some middlemen who are inefficient and dishonest cause both farmers and consumers to look with suspicion upon many so-called middlemen.

Farmers must realize that marketing services have to be

performed. Consumers as well as farmers should be greatly concerned with the efficiency of the marketing system.

Methods of Marketing. The direct system of marketing consists in selling farm products directly to consumers. Such consumers may call at the farm, stop at roadside stands or markets, or obtain farm products from farmers who deliver in villages or cities. Obviously, on a farm, a very small percentage of farm products can be sold directly to consumers; relatively few consumers live where they can take advantage of such a system.

A second method of marketing, which may be called the regular method, consists of farmers selling their products to local buyers or shippers. The local buyers, in turn, sell to a concern interested in buying farm products for resale. Such a system means that a series of complete transactions occurs whereby the ownership of farm products may change many times between the time the farmer sells and the consumer buys.

The chief weakness in this system is that the various marketing services are performed by persons more interested in making a profit than in performing marketing services in an efficient manner from the standpoint of farmers and consumers.

Cooperation may be thought of as the third method of marketing. In such a system a group of farmers may cooperate by developing an organization to perform a number of marketing services. If such a system is well operated from the standpoint of the consumer as well as the farmer, the chances for success are large. Many cooperative marketing organizations have failed because not enough attention has been given to business efficiency and to the problem of making the organization as satisfactory in its operation to consumers as to farmers.

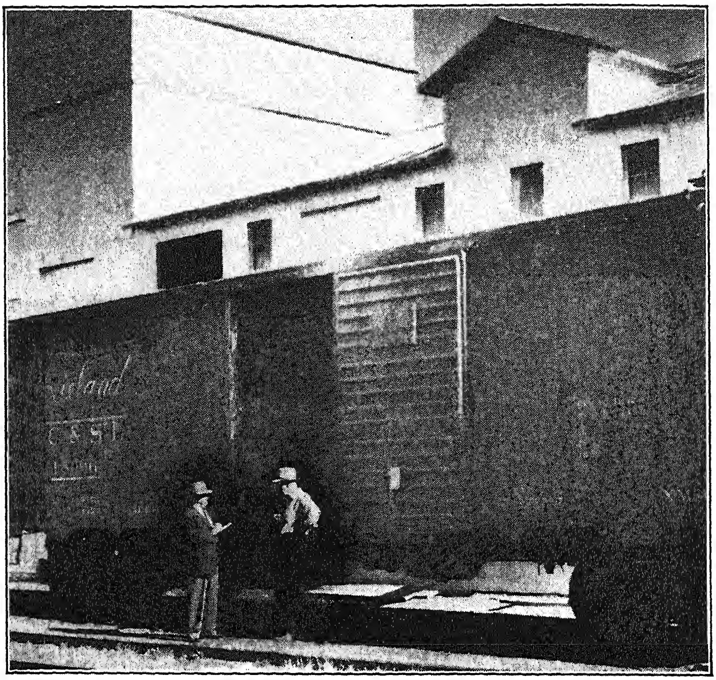
Many consumer cooperatives have been developed in the United States. Farmers have formed purchasing organizations to secure seed, feed, fertilizer, groceries, and many other commodities. In the same manner groups of city dwellers have formed consumer cooperatives with a view to carrying out cer-

tain marketing services. It may be expected that in the United States may farmer-controlled cooperative marketing organizations will deal directly or indirectly with consumer cooperative organizations.

Farmer cooperative organizations have done much to establish standards or specifications pertaining to the comomdities or materials which are handled. The work of the various agricultural experiment stations has been used by cooperatives to establish standards for the purchase and sale of feeds, seeds, fertilizers, insecticides, fungicides, equipment, and various other materials. Furthermore, the cooperative organizations have provided their patrons with information, derived from experimental investigation and from experience, on the best use and application of the commodities and materials provided by the organization. A farmers' cooperative belongs to its own membership, and therefore such an organization usually provides the broadest possible range of services to its patrons.

Prices of Farm Products. Any individual concerned with the marketing of farm products should be a student of the prices of farm products in which he has an interest. Prices are a result of certain combined forces. Before a present price for any commodity can be understood, the price of the same commodity must be studied over a period of years and in relation to the prices of other commodities that have any relation to it. When the various factors causing a price to vary are understood, it is possible to make reasonable estimates of what prices may be expected to be for some future period of time. For example, if the price of corn is high in relation to hogs, it may be expected that hog prices will not begin to rise until the supplies of hogs are reduced. Farmers will tend to put their hogs on the market because they cannot afford to feed high-priced corn to low-priced hogs. The price of hogs may be low because the supply of hogs is large in relation to the demand for pork products. Again, the price of wheat will be set within the United States as long as the supply of wheat is not larger than the demand in the United States. If the farmers of

this country produce more wheat than is needed here and are forced to sell wheat abroad, or, in other words, to export wheat, the price farmers receive for wheat will be a world price. The world price of wheat, often referred to in terms of the price



Southern States Cooperative

Inspecting and purchasing adapted alfalfa seed in northern Oklahoma.

of wheat at Liverpool, England, rises and falls according to the world supplies of wheat in relation to the world demand for wheat.

Prices of farm products are an index or barometer showing the result of certain factors which influence the price level. Every student of agriculture should watch prices and try to learn about the various things that cause prices to change.

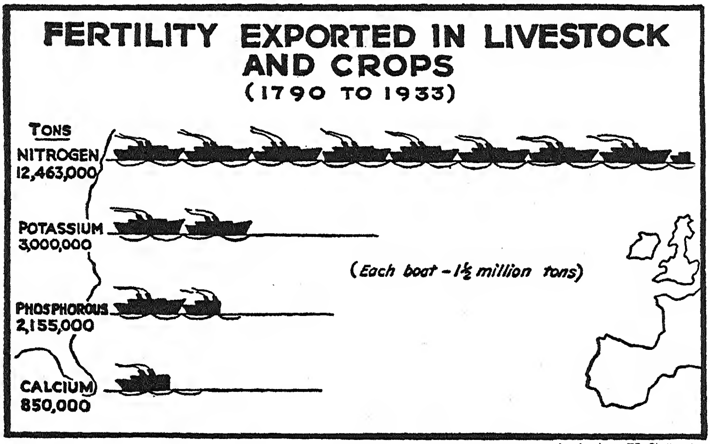
Farmers are often able to increase the returns from their farm production by learning to produce and market their products at the right time in regard to prices.

Federal Programs for Agriculture. The welfare of farmers and of consumers dependent upon agricultural production is of national concern. Many times Congress has passed laws of particular interest to farmers.

Farmer Cooperative Associations Stimulated by the Capper-Volstead Act. The foundation of the present-day development in cooperative farm marketing rests upon the Capper-Volstead Act passed by Congress in 1922. This legislation encouraged farmers to act together to secure the advantages resulting from large-scale operations on a service basis. The act provides that persons engaged in the production of agricultural products, farmers, planters, ranchmen, dairymen, nut or fruit growers, may act together in an association, corporate or otherwise, with or without capital stock, exempt from the anti-trust laws, in collectively processing, preparing for market, handling, and marketing in interstate and foreign commerce such products of persons so engaged. Associations qualifying under the act must be operated for the mutual benefit of the members, must not pay dividends in excess of 8 per cent per annum, and must restrict their members to one vote. Capper-Volstead associations must be governed by officers elected by the membership. They operate on a service basis and distribute costs and returns to patrons.

Since the passage of the Capper-Volstead Act, cooperative organizations have flourished, having as their chief objective the sale of farmers' products and providing farmer members with the best obtainable service, from the standpoint of price and quality, for such products needed in farm operation as seed, feed, fertilizer, binder twine, oil, and gasoline. Organizations under this act effectively handle the sales of farm products, such as grains, livestock, and dairy products, citrus fruit, truck crops, nuts, seeds, and other such commodities. Major cooperative associations that developed after the

passage of the Capper-Volstead Act are represented by the following: the Grange League Federation of New York; the Eastern States League of New England; the Southern States Cooperative; the Farm Bureau Service companies of Ohio, Indiana, Michigan, and other states; the Illinois Agricultural



A.A.A., U.S.D.A.

The principal elements of fertility removed from our soils in crops and livestock products exported and consumed represent an appalling total. Farmers must receive a price for their products sufficient to practice adequate methods of soil conservation and return essential elements of fertility by proper use of commercial fertilizer.

Association; the Land O'Lakes Cooperative Association of Minnesota; the California Fruit Growers, Incorporated; the Florida Citrus Growers Clearing House Association; the National Livestock Producers.

The Federal Farm Board. The Federal Farm Board was the second major effort of the government to relieve the farmer. From its organization in 1929 until May 1933, when it was succeeded by the Farm Credit Administration, the Federal Farm Board made loans for the aid of agriculture amounting approximately to one billion one hundred and fifty million

dollars. These loans were drawn from a revolving fund of five hundred million dollars appropriated by Congress. The loans were made for the most part to grain and cotton stabilization corporations, to agricultural cooperative associations chiefly through Federal Intermediate Credit banks, to national, regional, and state cooperatives, and to six great national cooperatives dealing in grain, cotton, wool, livestock, nuts, fruits, and vegetables. Loans were made also to cooperative producers of poultry, tobacco, rice, grass seed, sugar beets, beans, soybeans, apples, oranges, cherries, grapes, mushrooms, vegetables, honey, and coffee.

The program under the Farm Board was not protected by adequate production-control features. Purchases made by the Farm Board and the cooperative operations financed by the board resulted in the accumulation of tremendous surpluses of cotton, wool, seed, beans, wine-bricks, and many other commodities. Without an adequate control of production in line with demand and reasonable reserves, the stabilization activities and price pegging of the Farm Board were foredoomed to failure. At the end of the last fiscal year of Farm Board operation, 1932, the losses from the five-hundred-million-dollar revolving fund amounted to three hundred forty-four million nine hundred thousand dollars. The losses were costly but for a brief period they were offset by temporary price increases above the world market on wheat, cotton, and other products. The existence of tremendous surpluses under government control far beyond market needs of basic commodities contributed to the exceedingly low prices of 1932 for wheat, cotton, corn, and tobacco. The Farm Board closed its operations and gave place to the Farm Credit Administration in 1933, the Board's chairman recommending that every third row of cotton be plowed under and that adequate means for the control of agricultural production be associated with any future method of federal aid to agriculture.

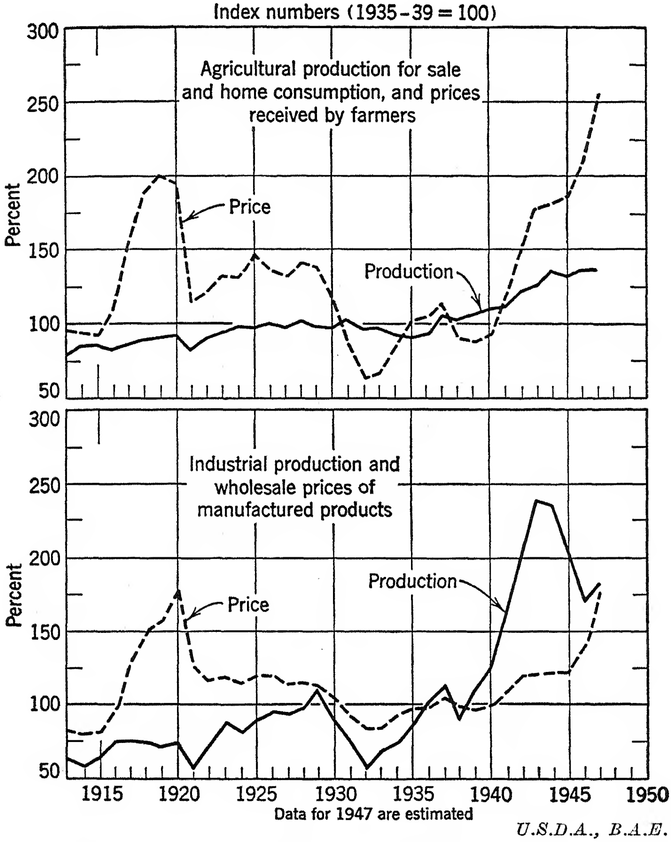
The Farm Credit Administration. The Farm Credit Administration took over the assets and obligations of the Federal

Farm Board in March 1933 and was faced with the immediate duty of disposing of the accrued surpluses of agricultural commodities owned or financed by the Federal Farm Board. This was done without undue disturbance of market conditions. A new program of farm finance was immediately inaugurated. Under W. I. Myers, governor of the Farm Credit Administration, all the federal agencies and functions dealing with agricultural credit were consolidated in one organization.[1] Farmer cooperatives are served through the Cooperative Bank of the Farm Credit Administration. Short-term loans of one and two years were offered to farmers through local production credit associations. Emergency seed and drought loans were continued to meet drought and other emergency needs. All counties of the United States were brought under a unified program so that farmers could become associated with farm-credit organizations and secure either short- or long-time credit, at a central farm-credit organization serving their county. For the first time farm credit was adjusted to the particular needs and the seasonal requirements of farmers and stockmen at rates of interest ranging from 3½ to 5 per cent, according to the character of the loan.

The Agricultural Adjustment Act. The Agricultural Adjustment Act was passed by Congress and received the approval of the President on May 12, 1933. It was designed to meet the acute economic emergency of the depression, and it aimed to restore the purchasing power of American farmers to a level equal to that experienced during the five-year period, 1909 to 1914, immediately preceding World War I. The cotton program of 1933 aimed to reduce the amount of cotton by 40 per cent. Since the cotton crop had largely been planted after the passage of the act in May, cotton farmers cooperating

[1] The Farm Security Administration, now the Farm and Home Administration, was established to render service to small farmers and secure farms for families without land. Thousands, formerly tenants or farm laborers, were enabled by this agency to operate successfully and eventually to buy their own farms.

in the program agreed to plow up 40 per cent of their crop. The corn program began in the fall of 1933 with loans of 45



Farm prosperity and industrial prosperity are closely linked.

cents per bushel on 263,000,000 bushels of corn stored in cribs of growers on the farm. These loans raised the market price from 30 cents to 45 cents. Corn growers in 1934 took part in a cooperative program that reduced their acreage by approximately 20 per cent. The wheat program of 1933 aimed

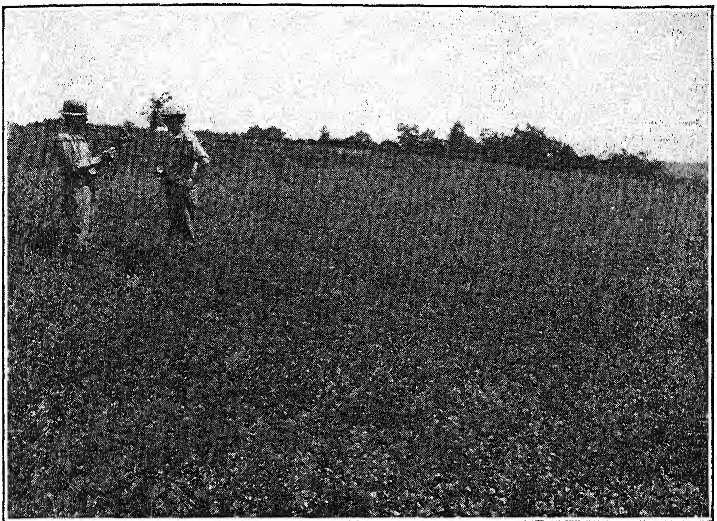
to reduce by 20 per cent the wheat acreage of cooperative growers as a result of agreement among them. The tobacco program required in 1934 an agreed reduction of 30 per cent in acreage on the part of growers. The effect of these programs was to raise the price of cotton almost immediately from about 5 cents to more than 12 cents per pound; of corn from 30 cents, or less, to 45 cents, and, as a result of the drought of 1934, to approximately $1.00; of wheat from 45 cents to more than $1.00.

The acreage taken out of wheat, corn, and tobacco, known as the contracted or adjusted acreage, was available under the terms of the contract for new seedings of grasses, legumes, soil-improving and soil-conserving crops in general, tree planting, planting home food and feed crops, and emergency forage crops during the drought of 1934 as provided in the contracts authorized by the Secretary of Agriculture. Marked increases in the planting of alfalfa and soybeans resulted in Northern and Corn Belt States, and of lespedeza in Central and Southern States. The home, food, and feed program of the South was given great impetus. It is estimated that more than three million farmers cooperated annually by signing contracts or engaging in marketing agreements under the Agricultural Adjustment Act until January 1935, when the control features of the Adjustment Program were declared unconstitutional by the Supreme Court. Six members of the Supreme Court voted the act unconstitutional, and three members signed a dissenting opinion to the effect that the decision should be reversed. The primary purpose of the A.A.A. was to raise prices of farm products. In 1932, gross income to farmers had reached the low point of five and one-third billion dollars. In 1935, the gross income to farmers exceeded eight and one-half billion dollars, and during the war years it exceeded twenty billion dollars.

The A.A.A. was reorganized to form the present Production and Marketing Administration.

Purchases of surplus products for relief use and for more orderly marketing were arranged through the agency of the Surplus Commodity Corporation.

The Soil Conservation Service was established by act of Congress in 1933 to ascertain by research the most effective

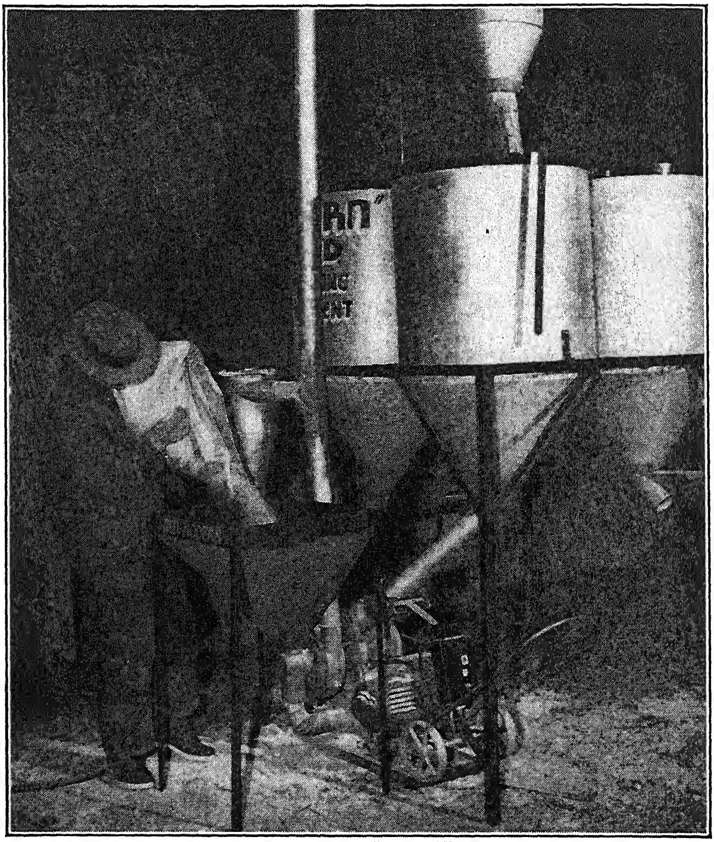


U.S.D.A.

The planting of soil-conserving crops, such as alfalfa, clover, sweet clover, and pasture grasses, was encouraged on the "contracted acreage," shifted in the A.A.A. control program from corn, wheat, cotton, and tobacco.

soil-conservation practices and to bring these practices into widespread use by cooperation with farmers, state agencies serving farmers, the agricultural adjustment administration, and other federal agencies. A following amendment provided for the establishment of state conservation districts, and most states have passed laws authorizing them. Farmers within soil-conservation districts are provided with advice and assistance in the planning and execution of the most effective soil- and water-conservation practices.

The Agricultural Conservation Program. The Congress of the United States, in March 1936, amended the original Soil Conservation Act to provide for the Federal Agricultural Conservation Program. In 1936 this act carried an appropriation from the Treasury of five hundred million dollars and author-



Rural Electrification Administration

Electrically powered seed-and-grain cleaning, elevating, and drying machinery is now widely used. More than 60 per cent of the farms in the United States are now electrified.

ized the expenditure of the money for the purpose of conserving the soil and maintaining parity prices. Under the administration of the act, direct payments or awards were made to individual farmers cooperating in the shifting of acreage devoted to soil-depleting crops to crops recognized as soil-conserving. Special awards were authorized in payment for such practices as liming, fertilizing, erosion control, tree planting, seeding additional acreages to legumes and grasses, pasture and meadow improvement, and the control of noxious weeds. The sound practices of crop rotation and fertility improvement long recommended by the land-grant-college experiment station and able farmers were substantially subsidized and encouraged under the Agricultural Conservation Program.

During World War II our farmers and all agencies serving agriculture were mobilized for the utmost production of war crops such as corn, small grains, flax, hemp, soybeans, legume and grass-seed crops, long-staple cotton, milk, meat, poultry, and seed.

As stated by M. L. Wilson, under secretary of Agriculture:

> In the place of expansion and carelessly exploited resources, the nation must plan for conservation and efficient use of the resources that it has.
>
> Instead of unlimited agricultural production and greatly varying prices, the new policy must call for balanced production and fair prices at relatively stable levels.
>
> Instead of sending huge shipments of farm products abroad at prices which did not compensate for the loss of fertility sustained by the soil in producing them, the nation must conserve its soil resources to meet present and future needs at home, and to supply such export markets as are available at adequate prices.
>
> All these readjustments should make for saving instead of wasting the surplus wealth of the land, for re-investing surplus wealth in improved living for the people.
>
> "Plenty without waste." This should serve as a slogan for the future—a program which recognizes the farmer, the farm, the consumer, and the citizen of the future.

SUGGESTIONS

1. Secure any available information in the form of bulletins or pamphlets describing the work of marketing agencies doing business in the local community.

2. Arrange for trips to inspect various marketing agencies handling agricultural products.

3. Trace certain farm products produced locally through the marketing process until the consumer has been reached. Make note of the marketing services which are essential in the process.

4. Trace a farm product not produced in the local community from the time it leaves the farmer-producer until it has reached local farmers who are consumers of that product.

5. Make a study of certain prices of local interest by preparing charts on which can be placed the daily, weekly, or monthly price reports. If the charts show the prices for some period of past years, the trend of present prices may be compared to that of past periods for seasonal trends. Such charts may well be started at the beginning of a school year and kept up to date by students.

6. The prices for certain commodities should be studied in relation to each other. The hog-corn ratio is an example of such a relationship. The hog-corn ratio is expressed in terms of the number of bushels of corn which may be purchased by the sale of 100 pounds of pork. If 100 pounds of pork can be exchanged for 11 or more bushels of corn, then, in general, it is profitable to feed corn to hogs because corn is relatively cheap.

The price of feed is an important factor in any farming program in which crops are fed in the production of livestock or livestock products for market.

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CHAPTER XV

CONTROLLING CROP DISEASES

The annual crop loss from plant diseases, practically all of which can be controlled, is the cause of tremendous financial loss to the farmers of the nation. Black stem rust of wheat has been known to ruin the wheat crop of extensive regions with dire financial loss to wheat growers. Late blight of potatoes during weather conditions favoring the blight may ruin the potato crop. The great famine in Ireland in 1840 is attributed to the failure of the potato crop due to the blight. Stinking smut of wheat reduces yields and impairs the milling quality of wheat; many wheat growers receive great reductions in the market price for smut-infested wheat. Anthracnose, a summer disease of red clover, and wilt in alfalfa are causing increasing losses in the production of these crops.

Practically all these losses can be greatly reduced or wholly controlled by proper measures and good farming practices.

The following practices are effective in preventing losses from plant diseases:

1. Grow crops in rotation.
2. Practice clean farming methods.
3. Use fertilizers that increase vigor of growth.
4. Plant clean seed.
5. Grow disease-resistant varieties.
6. Use effective seed treatments.
7. Use chemical sprays and dusts.

Grow Crops in Rotation. Many plant diseases are effectively controlled by growing crops in proper rotation. The potato scab and the black scurf of potatoes cause little loss when potatoes are grown in planned rotations and are planted

on a particular piece of ground not oftener than once every four to six years. When potatoes follow potatoes or come too frequently in rotation, the scab and black scurf cause the greatest injury. After liming, or on soils high in calcium, potatoes are likely to be more seriously affected by potato scab. In soils that are slightly acid, potatoes develop comparatively little scab injury. Leaf spot of sugar beets, a fungus disease, and the blight of beans, a bacterial disease, are held in check by including these crops in rotation not oftener than every four to six years.

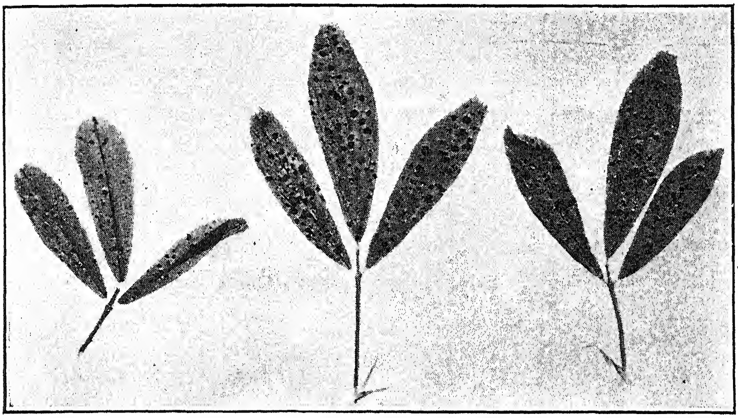
Corn smut is generally controlled by crop rotation.

Corn smut causes greatest damage in fields where corn follows corn or where it is grown too frequently in rotation. Losses from corn smut are greatly reduced when corn is grown in rotations including small grains and clover or alfalfa.

Practice Clean Farming Methods. Crop remains, such as stubble, straw, and diseased seeds, often cause damage by spreading plant diseases. Anthracnose in beans may be carried through the winter on affected bean pods and shattered beans that remain on the land. Scab and rust of wheat also may be carried over in stubble and straw, particularly in northern regions where deep snow comes early and remains until early spring. Ergot in rye is carried over in the residues of affected plants. Many related weeds may be a source of infection to crops. Volunteer rye is often infested with ergot,

and the organisms causing anthracnose and blight live on many weeds and grasses. Such diseases are readily transferred to cultivated crops from wild grasses and weeds.

Fall plowing and early spring plowing, the eradication of weeds, and the cleaning up and feeding of straw reduce the hazards from many plant diseases.



Leaf spot, a fungus disease of alfalfa generally controlled by cutting for hay.

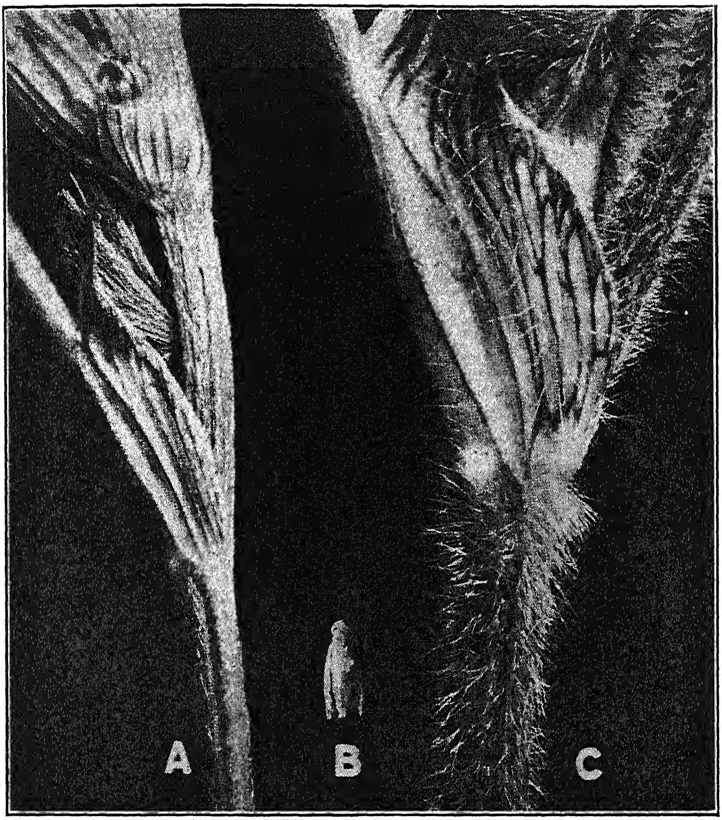
Use Fertilizers that Increase Vigor of Growth. If the vitality of crops is increased, the damage from most plant diseases is reduced; hence the use of fertilizers, tile drainage of land, and good cultural practices reduce the loss from crop pests.

Plant Clean Seed. Many plant diseases are seed-borne. Anthracnose in beans and wilt in peas are notable instances. Planting clean seed greatly reduces losses from these diseases. The commercial production of seed peas and seed beans is of greatest importance on new land in the Northern States and in regions of the West where bean anthracnose and pea wilt do not occur. Wheat that carries smut balls should not be planted unless thoroughly cleaned and treated. Clean seed

is preferable. Rye mixed with ergot bodies should be avoided for seed purposes. Potatoes that show discoloration when cut may be affected by late or early blight or virus diseases. Potatoes showing scab or black scurf should be avoided, or carefully treated if used for seed. Planting clean seed, free of disease, greatly reduces possible injury.

Grow Disease-Resistant Varieties. During recent years the plant breeders of agricultural experiment stations and of the United States Department of Agriculture have achieved remarkable results in developing strains or varieties of crops immune or resistant to plant diseases. Many will not release high-yielding crop varieties unless they are also resistant to prevalent crop diseases. Among the notable developments of disease-resistant varieties are the Thatcher wheat of the Minnesota Experiment Station, resistant to black stem rust; the Robust bean of the Michigan Experiment Station, immune to bean mosaic and resistant to blight; the Markton oat of the Oregon Experiment Station, resistant to smut; the Marglobe tomato of the United States Department of Agriculture, immune to tomato wilt. Certain varieties of Turkistan alfalfa are immune to alfalfa wilt and are being extensively employed by plant breeders in hybridizing with hardier and higher-yielding alfalfa varieties, such as the Grimm and Hardigan, in an effort to secure high-yielding, hardy, wilt-resistant varieties of alfalfa. European red clovers are particularly susceptible to anthracnose and other summer diseases and are lacking in winter hardihood.

The work of the United States Department of Agriculture in securing disease-resistant strains of sugar cane saved the United States sugar-cane industry from failure. Use of these disease-resistant varieties has increased greatly the production of sugar from sugar cane. Cabbage varieties resistant to club root and yellows have been developed. Crop plants of disease-resistant varieties of high-yielding ability should be secured by the farmer when available.



Dr. E. A. Hollowell, Bureau of Plant Industry, U.S.D.A.

(A) Red clover from Europe has smooth stems and leaves. (B) Leafhoppers do great damage to the smooth-stemmed clovers. (C) Our hardy domestic red clover has hairy or pubescent stems and leaves and suffers much less from anthracnose or other summer disease and from winter-killing than imported European red clover.

Use Effective Seed Treatments. Treatment of seed with effective chemical solutions or chemical dusts or other means that control diseases is now recognized as an important and essential farm practice in the production of many crops. Failure to treat seed frequently causes the farmer to receive little or nothing for the work and expense of plowing the ground, fitting the seed bed, and planting and cultivating his crop. Seed treatments usually cost little, take little time, and may be regarded as an exceedingly valuable form of crop insurance.

Treating Seed Grain

For the treatment of seed grain the United States Department of Agriculture advises the following: [1]

After seed grain has been thoroughly cleaned, treat it according to the following directions for controlling the seed-borne diseases listed below:

Crops and Diseases	*Seed Treatment*
Spring wheat (hard red, white, and durum):	
Stinking smut (bunt)	No. 1, 2, or 5 *
Winter wheat:	
Stinking smut (bunt)	No. 1 or 2
Oats:	
Loose and covered smuts	No. 2, 3, 4, 5, or 6
Barley:	
Covered smut and black loose smut	No. 2, 3, 5, or 6
Stripe	No. 2
Grain sorghum:	
Covered kernel smut	No. 1

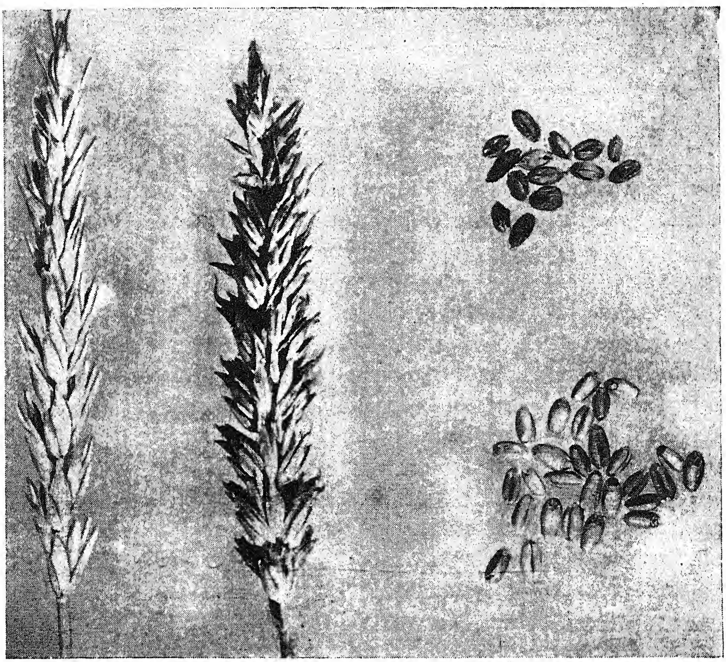
* Numbers refer to descriptions following.

[1] *Miscellaneous Publication* 219.

No. 1. Copper Carbonate Dust Treatment

(Applicable to spring, winter, and durum wheats for stinking smut control, and to sorghums for the control of covered kernel smut. Not applicable to oats and barley.)

Use a full-strength copper carbonate dust (about 50 per cent copper), manufactured especially for seed treatment. Apply at the



The stinking smut, or bunt, in wheat.

rate of 2 to 2½ ounces per bushed of well-cleaned seed. Mix the seed and the dust in a tight mixing machine until every kernel is thoroughly covered with the dust. Seed thus treated may be stored indefinitely until sown, without injury to germination. With this chemical, care must be used to avoid damage to the grain drill. Sometimes there is a tendency for the treated seed to cake in

the drill, when standing overnight, or longer, in damp or wet weather. In such cases it is advisable to rock the drill wheels back and forth before starting in order to avoid breaking or bending the working parts. All working parts of the drill should be kept well oiled. The treated grain should be well cleaned out of the drill when seeding is completed to avoid corrosion of the parts. Seed treated with copper carbonate should not be fed to farm animals.

No. 2. Ethyl Mercury Phosphate Dust Treatment (Improved Ceresan)

(Applicable to spring, winter, and durum wheats, oats, and barley, for the control of all diseases listed above.)

Use ethyl mercury phosphate dust manufactured especially for seed treatment. Apply at the rate of one-half ounce per bushel in a mixing machine, or as recommended in directions on the container. The dusted grain should be kept in a bin, pile, wagon box, or sacks for at least ten hours. During this period dusted grain should remain uncovered. Treated grain may then be seeded at once or stored for at least four weeks. Ordinarily, grain should not be treated more than four weeks before seeding time because of uncertainty as to the effect on seed germination after this period. This treatment has the advantage of being applicable to wheat, oats, and barley, is easily applied, does not cake in the drill, and is noncorrosive to drill parts. As in the case of copper carbonate, seed treated with this chemical should not be fed to farm animals. Do not apply more than one-half ounce of this disinfectant per bushel. An excess may injure germination.

No. 3. Formaldehyde Dust Treatment

(Applicable to oats for the control of oat smuts and to barley for the control of covered smut and black loose smut. Does not control barley stripe.)

There are several brands of formaldehyde dust on the market. They contain from 4 to 8 per cent of commercial formaldehyde by weight. These are usually applied at the rate of about three ounces per bushel (see directions on container). Use a tight mixing

machine or apply by the shovel method. Pile and cover with canvas, blankets, or sacks for at least one day. Then sow as soon as possible. This is a convenient treatment for oat and barley smuts, but as noted above, it does not control barley stripe. Not recommended for wheat because it does not control stinking smut and may injure germination.

No. 4. Formaldehyde Spray Treatment (Dry)

(Applicable only to oats for smut control.)

Mix one pint of commercial formaldehyde with one pint of water. Apply this mixture uniformly with a sprayer at the rate of one quart of the mixture to fifty bushels of seed as it leaves the grain spout or as it is being shoveled from one pile to another on a clean floor or canvas, or in a tight wagon box. Bin it or pile and cover with canvas, blankets, or disinfected sacks for at least five hours, or overnight. Then sow immediately or expose to air before storing for any length of time. If treated grain is stored in an elevator it should be moved and aerated on the following day. This is a convenient method for treating large quantities of seed oats rapidly.

No. 5. Formaldehyde Dip Treatment (Wet)

(Applicable to spring wheat, durum wheat, oats, and barley. Does not control barley stripe.)

Mix one pint of commercial formaldehyde with 40 gallons of water in a barrel or tank. For best results the temperature of the water should be about 60° to 70° F. Dip loosely filled burlap sacks in this solution until the grain is thoroughly wet. Drain and dry two hours, or overnight. Then sow immediately. If the sowing must be delayed, spread out the treated seed to dry and sow as soon as possible. Formaldehyde-treated oats may be held longer than treated wheat without injuring germination. The treatment sometimes injures germination to some extent, particularly in the case of wheat when held for some time after treatment or when sown in dry soil. Treated seed should not be allowed to freeze while it is damp or wet. If grain is moist, increase seeding rate about one-fourth.

No 6. Formaldehyde Sprinkle Treatment (Wet)

(Applicable to oats and barley. Does not control barley stripe.)

Mix one pint of commercial formaldehyde with 40 gallons of water at a temperature of 60° to 70° F., and, with a sprinkling can, sprinkle it uniformly on 50 bushels of seed grain as it is being shoveled from one pile to another on a clean floor or canvas, or in a tight wagon box. Shovel until all the seed is thoroughly wet. Pile and cover with canvas, blankets, or disinfected sacks for at least two hours, or overnight. Then sow immediately. If the sowing must be delayed, spread out the treated seed to dry and sow as soon as possible. This treatment has the same limitations as No. 5. Treated seed should not be allowed to freeze while it is damp or wet. If grain is moist, increase seeding rate about one-fourth.

CAUTION! Copper carbonate and ethyl mercury phosphate (Improved Ceresan) dust are poisonous, and formaldehyde fumes are irritating. Therefore, avoid inhaling these compounds as much as possible. Treat seed in a well-ventilated place or outdoors. Wear a dry cloth or a dust mask over the nose and mouth.

Treating Equipment

Equipment for applying dust to seed grains ranges all the way from home-made hand mixers operating at the rate of 25 to 30 bushels an hour to commercial, automatic, power-driven, and gravity-type mixers handling 200 to 500 bushels per hour.

Large-scale seed treatment by local elevators, seed houses, central treating plants, or portable treating outfits is practical and valuable, and is increasing in popularity. By means of it, farmers can be relieved of the inconvenience of treating, and a more uniform and satisfactory job of treating can be done. The task is much easier now than it was several years ago. New materials, methods, and equipment make it possible to treat seed rapidly and effectively at a very low cost per bushel. If it is not desired to purchase a large-capacity commercial machine there are several types of apparatus that can be constructed by local carpenters or sheet-metal workers to handle 200 to 500 bushels an hour.

For spraying formaldehyde on oats, all that is needed to treat a large volume is a good garden sprayer. Nozzles are selected and

the sprayer is arranged in such a way as to spray a mist into the falling stream of grain at the rate of one quart of the half-and-half formaldehyde solution to 50 bushels of oats.

For applying formaldehyde as a sprinkle or dip there are also several kinds of machines available. Some soak the grain and skim off smut balls, chaff, and lightweight seeds that float to the top, some soak the grain but do not permit skimming, while others sprinkle the seed as it falls past a jet of formaldehyde solution.

For further information consult your county agent or write your state extension service or the United States Department of Agriculture.

Hot-Water Treatment for Loose Smut in Wheat [2]

Life History of Loose Smut

This disease appears at about the time the wheat heads out. The wheat head appears as a mass of black smut spores instead of the normal head. This differs from stinking smut, or bunt, in wheat in that the entire head is a mass of smut, whereas the stinking smut affects only the individual kernels.

When the wheat heads begin to blossom, that is, when pollenization takes place, the loose smut spores are blown to the blossoms. Here they germinate and the young smut threads, or hyphae, grow with the developing wheat kernel so that when an infected kernel reaches maturity the smut is within the kernel itself. When the infected wheat kernel is planted in the fall, the smut grows with the young wheat plant as though it were a part of the plant. It continues to grow as a part of the wheat plant and at no time can such smut-infested plant be distinguished from a normal plant until it develops the smut head instead of the normal wheat head. The infected wheat plant seems to lose some of its vigor, and because of this, when winter-killing is prevalent, these smut-infested plants are the first to be killed.

At harvest time the presence of this smut in the wheat is

[2] Michigan Experiment Station, G. W. Putnam.

indicated only by the appearance of the straws which bore the smut head; the wheat kernels seem to have been washed off, and only the naked straw is left. These are usually in clumps of three to five, representing the straws of an entire plant. This smut does not injure the milling quality of wheat as does stinking smut.

Treatment

The use of disinfectants such as formaldehyde or copper sulphate is not effective in controlling this disease, because the smut is present within the kernel itself rather than as a spore adhering to the kernel, as in stinking smut.

Treatment, then, must kill the fungus, which occurs as a part of the wheat kernel. Heat has been found to be the only effective treatment. The following outline presents briefly the method followed in the hot-water treatment for loose smut of wheat:

1. Soak wheat 4 to 6 hours in cold to lukewarm water.
2. Dip for 1 minute in water at 120° F.
3. Soak for 10 minutes in water at 129° F.
4. Dip for 1 minute in cold water.
5. Spread not more than 2 inches thick on clean canvas or floor to dry.

Equipment

1. A source of live steam.
2. Three barrels or similar containers.
3. Water.
4. Floating dairy thermometer that will register 129° F.
5. Gunny sacks or screen baskets.
6. Clean canvas or floor.

A source of steam can usually be obtained at the local creamery or by use of the special apparatus herein described.

If steam is to be obtained from the local creamery, the wash vats usually are used for water containers. If the milk can is used for generating steam on the farm, barrels are convenient for soaking and treating grain.

When the water is heated by steam, the steam must be controlled by means of a valve or similar arrangement. Open, porous gunny sacks, tied loosely, permit uniform heating of the wheat.

Cautions

1. Fill the milk can entirely full of water before starting the fire under it.
2. Be sure to have only one hose with a valve connection. Leave the other hose open all the time "to avoid blowing up." Adjust the temperature in barrel 2 by taking this open hose out or putting it in, as the case may be. It will speed up operations to put both in barrel 3 at the start.
3. Leave the hose with valve connection in barrel 3 to give accurate adjustment of temperature in this barrel.
4. A 5-gallon milk can will generate steam for about 3 hours on one filling with water. To refill, remove can from fire and always fill entirely full, to avoid melting of solder, before setting back on fire.
5. Drain sacks on drain boards between barrels.
6. Be sure to spread grain thinly to dry.
7. Have the grain soaked in barrel 1 ready to treat before barrels 2 and 3 are heated.
8. Follow instructions on length of treatment and temperatures to use.
9. You can injure germination by treating too long or by allowing temperature to get above 130° F. Temperatures below 126° F. are not effective.
10. It is a good plan to run germination tests before and after treatment.
11. Get a reliable floating dairy thermometer to use in barrel 3. To take temperatures during treatment, stir grain with the thermometer.
12. One bushel of grain tied loosely in a gunny sack allows for uniform heating.

Loose Smut in Barley

This disease is very similar to loose smut of wheat, since it causes the development of a mass of black smut and the dis-

appearance of the head of barley. Infection takes place when the head is in flower.

The hot-water treatment given above for the control of loose smut of wheat controls effectively loose smut of barley if a lower temperature is used. The temperature of the water should be 126° F. (or from 124° to 129°) for 13 minutes. Soak before treatment 4 to 6 hours in cold water, as for wheat treatment.

Seed Treatment for Black Scurf and Scab in Potatoes [3]

Select only sound, desirable tubers for treatment. Scabby, bruised, or partially rotted tubers are unsafe.

Treat seed tubers in the following ways:

Corrosive Sublimate Treatment

Soak the seed tubers in corrosive sublimate solution for one-half hour. The solution is made with 4 ounces of corrosive sublimate in 30 gallons of soft water. This treatment controls scab and black scurf. Reinfection from untreated sacks must be avoided. Disinfect these containers in the treating solution.

Large quantities can most readily be handled in a large vat made of heavy material, which can hold 8 to 12 crates at a time. It is well to make this vat watertight by use of heavy duck lining, painted with some waterproof paint, such as asphaltum. Cement vats are also excellent. The solution becomes weaker with use. It loses strength because the potatoes take out more chemical than water. Hard water brings about a weakening of the solution. Sacks and dirt also take up the fungicide; hence potatoes to be treated should be free from dirt and should *not* be treated in sacks.

The addition of 1 ounce of corrosive sublimate to 30 gallons of solution after each batch is dipped keeps the treating solution at the proper strength. When potatoes are fairly

[3] *Michigan Experiment Station Special Bul.* 125.

clean, the addition of 1 ounce of corrosive sublimate after every other batch is sufficient.

Experiments completed in 1917 show that treatment for one-half hour is as efficient as the longer soaking (1½ to 2 hours) previously advised.

Points on the Treatment. Corrosive sublimate crystals or the diluted solution are *deadly poison.* Use precaution and keep this material out of the way of livestock or children.

The crystals dissolve slowly in cold water, but rapidly in hot water.

Treated tubers are not safe to feed to stock.

Corrosive sublimate, as the name indicates, attacks metals. It must not be used in metal tanks.

Potatoes should be uncut when soaked.

Treatment of small lots can be given readily in a barrel, 2 bushels at a time.

Formaldehyde Treatment

If the farmer knows the signs of black scurf on the tubers, and if he will consistently reject *all* tubers showing the purple-black masses when they are cut, the old formaldehyde treatment, known for a long time for use against scab, may safely be employed.

Soak the uncut potatoes for 30 minutes in formaldehyde solution made with 1 pint of concentrated formaldehyde (36 to 40 per cent) in 30 gallons of water.

Points on the Treatment. This solution does not have the power to prevent the black scurf from causing infection after the tubers are planted, hence the necessity of close sorting when they are cut. Since black scurfs are very evident when the tubers are wet, cutting immediately after treating makes sorting easy.

Weak formaldehyde solution does not lose strength on standing, as is commonly supposed, but becomes slightly stronger. Unlike the corrosive sublimate, it may be used repeatedly for treating.

Treated potatoes are not desirable stock food, even when cooked, because of the very injurious effects of even slight amounts of formaldehyde on digestive processes.

This treatment is about one-third cheaper than the corrosive sublimate treatment.

Formaldehyde is a strong chemical. It is not safe to vary the strengths from those given. Measurement of water may be approximate, the farmer bearing in mind that a large barrel holds 50 gallons. For smaller lots, a large pail, holding 3 gallons, may be used for measuring. Metallic containers may be used with formaldehyde.

SUGGESTIONS

1. By inquiry, find out to what extent wheat is damaged by bunt, loose smut, scab, and rust in your locality; oats, by loose smut; barley, by covered smut and loose smut. Your threshermen can give you very accurate information on such losses.
2. What percentage of farmers treat seed grain with formaldehyde?
3. Estimate cost to individual growers who suffered loss from smut. What would it have cost them to treat their seed?
4. Is common barberry present in your neighborhood? Study specimens. Why should it be entirely eradicated?
5. Make a field trip in the fall to observe potato fields being harvested. Does black scurf, scab, or blight cause much injury? Was seed treated where scab and scurf were present to great extent? Note best and most disease-free crops as the potatoes came from the ground. What kind of seed was planted? How treated?
6. During the fall field trip, note amount of corn smut present in cornfields. How is it controlled?

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CHAPTER XVI

CONTROLLING INSECT PESTS

Every year in every community there are crop losses due to the work of insects. The losses vary from hardly noticeable forms of destruction to the complete loss of crops. Great sums of money are spent annually in the control of insects and when these are added to the value of the actual crops destroyed the losses due to insects are tremendous. The hazards or risks in farming are greatly increased by the ever-present menace of insect damage.

The various aspects of controlling insect pests are as follows:

1. Life cycle, characteristics, and habits of insects in relation to their control.
2. Types of insect controls.
3. Information on insect control.

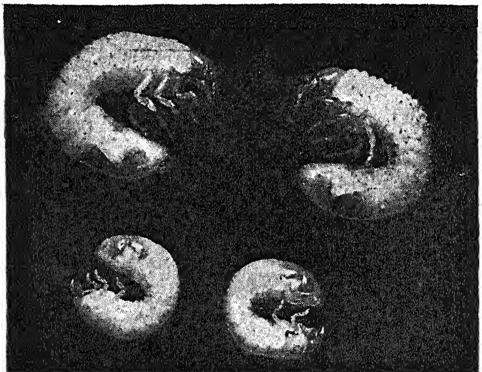
Life Cycle, Characteristics, and Habits of Insects in Relation to Their Control. A study of insects is called entomology, and entomologists are persons who devote their time to the study of insects. These investigators have formulated many effective plans for controlling insects.

Insect Metamorphosis. Metamorphosis refers to the change which insects pass through in their life cycle. The typical or complete life cycle of insects may be described in the following stages: the egg, the larva (worm); the pupa (cocoons often formed); the adult insect. Some insects such as the grasshopper do not pass through all these stages and are said to undergo incomplete metamorphosis.

Most insects do their greatest damage to crops in the larval

or worm stage. It is in this stage that they make the greatest growth and require, therefore, the most food. The adults of many insects eat very little and sometimes nothing. Their function is to breed and produce eggs.

If the life cycle of insects is understood, it is often possible to formulate plans for controlling or destroying them. It is possible, for example, to prevent Hessian fly damage to wheat



R. H. Pettit, Michigan Exp. Sta.

White grubs, the larvae of the June beetle, often cause much damage to pasture sods and to corn crops following.

if it is known when the fall broods of flies emerge and lay their eggs, and if the planting of winter wheat is delayed until after that date. Grasshoppers may be killed in the egg stage if certain cultivation practices are used. One of the most common is to poison insects in the larval or worm stage.

Eating Habits of Insects. Many methods of destroying insects are based upon their eating habits. Certain insects have mouth parts with which they bite off portions of the parts of the plant they are feeding on. These insects may be classified as chewing insects. Poisonous material placed on the plant destroys such insects unless they work inside the plant and are allowed to get in without being destroyed. Grasshoppers and potato beetles are examples of chewing insects.

R.A., U.S.D.A.

Grasshoppers often do great damage, particularly in dry years.

Other types of insects have sucking mouth parts and are therefore classified as sucking insects. They obtain their food from plants by thrusting portions of their mouth parts below the surface of the stems or leaves in order to suck sap from the plant. They obtain their food from plants much as a mosquito sucks blood from animals. These insects are not destroyed by poisons on the surface of the plant but must be destroyed by contact sprays or other means. The various types of plant lice or aphids are sucking insects.

Insect Breathing or Respiration. Insects breathe through many pores or holes in the surface of their bodies. Certain spray or dust materials coming in contact with the insects tend to clog the breathing pores and thus destroy the insects. Other insect poisons, such as carbon disulphide, are in the form of a gas which, when breathed in, kills the insects as certain gases kill animals.

Types of Insect Control. There are several types of insect control, both natural and artificial.

Natural Controls. Insects are greatly affected by weather conditions. Moist cool weather, for example, causes bacterial and fungus diseases of insects to spread rapidly; these destroy great numbers of insects.

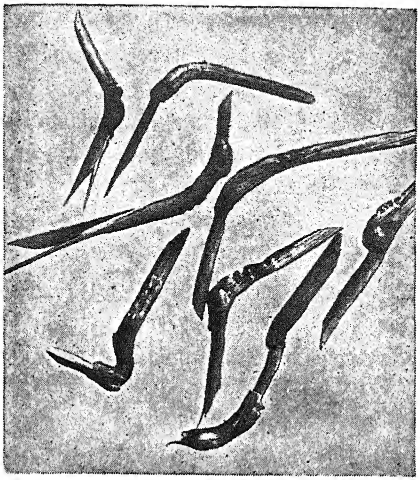
Certain spiders and insects prey upon other insects. Types of ladybird beetles, for instance, devour scale insects.

Parasite insects lay their eggs in the eggs or larvae of other insects and, as a result, the insect which is host to the parasite is generally destroyed.

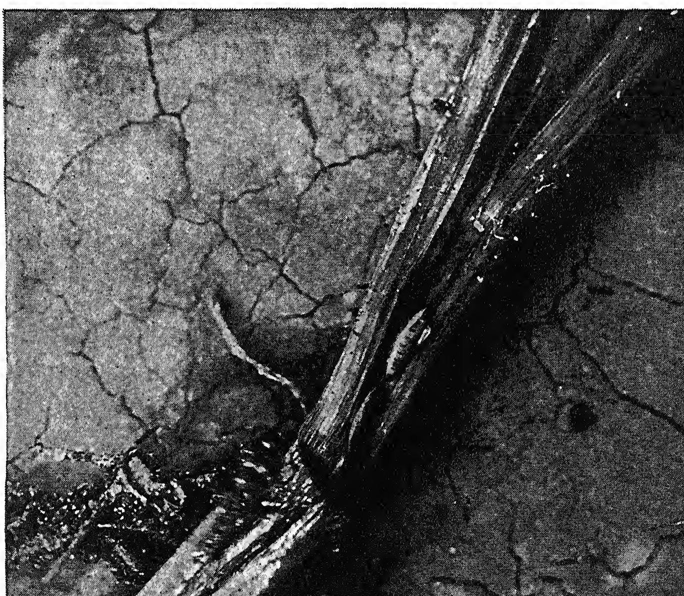
The insect population is kept down also by various insect-eating birds and animals.

Chemical Controls. Man has learned to use many chemical products in his battle with insects.

A. Stomach Poisons. Compounds containing arsenic, lead, fluorine, copper, and mercury are used as sprays or dusts. These compounds bring death when they are eaten by insects. Such materials are used in various combinations and amounts. Information about recommended practices for specific insect-



The joint worm causes swelling at joints or nodes of wheat straws. Controlled largely by rotation.



R. H. Pettit

The Hessian fly, controlled by planting at fly-free dates.

Two damaging wheat pests in Eastern and North Central regions.

control problems may be secured from bulletins published by the state college of agriculture.

For grasshoppers and cutworms stomach poisons are often prepared in the form of a mash or bait to be scattered where the insects are at work.

A salted poison bait for grasshoppers consists of the following:

1 bushel hardwood sawdust
¾ to 1 pound salt
1 pound white arsenic, or Paris green, or arsenite of soda (not arsenate of lead)
3 ounces banana oil (amyl acetate)
Water to moisten

Dissolve the salt in water. Stir in the arsenic, mix the liquid into the sawdust, and add banana oil. *Mix thoroughly.* Broadcast where needed.

Other such baits are made of bran with a poison. The mixture is made attractive to insects by molasses, ground orange or lemon, and syrup.

Specific directions for using such poison materials may be secured from state college of agriculture bulletins dealing with insect control.

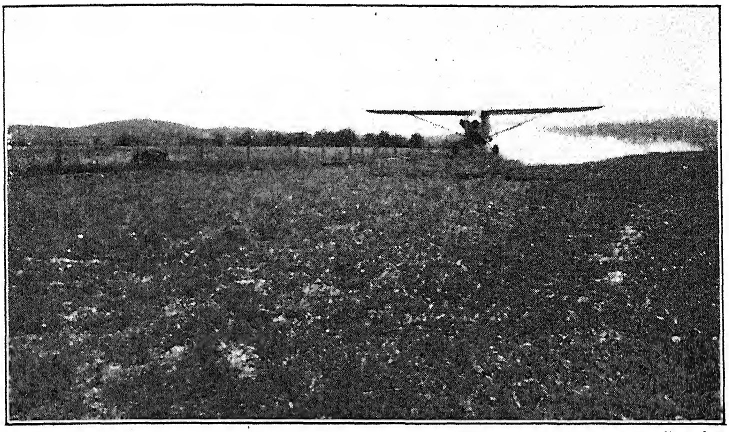
B. Contact Poisons. Nicotine compounds, lime-sulphur, formaldehyde, oils, soaps, and tar compounds clog the breathing pores or destroy insect tissues.

C. Respiratory Poisons. Gases of cyanide compounds, carbon disulphide, carbon tetrachloride, paradichlorobenzene, and other such chemicals destroy insects by getting into their respiratory tracts or breathing tubes.

D. DDT (Dichlorodiphenyltoluol) has been found through experimentation to be useful in destroying many insects, particularly those affecting the potato, the European corn borer, and leaf hoppers that reduce alfalfa and clover seed yields. It is important to follow the results of tests or the directions of reliable manufacturers in the use of DDT. Many other chemi-

cal substances which are being studied in relation to insect control will be made available.

Barriers. Sometimes insects may be controlled to some extent by barriers. Young chinch bugs do not have wings and consequently they can be kept from moving from small grain to corn by constructing a barrier. Such a barrier may consist



U.S.D.A. Extension Service

Airplane dusting to control insects of field crops is now widely employed. Planes are employed also in fertilizing and seeding pasture lands.

of a furrow plowed around a cornfield. At intervals of about a rod, post holes may be dug in the furrow to trap the insects. A line of crude oil should be poured along the furrow to keep the insect from climbing the furrow ridge. Sometimes a log is dragged along such a furrow to destroy the insects and to provide a dust mulch which deters the insects from crawling beyond the barrier. It has been found by the Iowa and Nebraska stations that dinitro-*o*-cresol dust is much better than creosote for use in barriers.

Selection of Crops and Cultural Practices. Plant breeders are making some progress in breeding varieties or strains of

crops which are more or less resistant to the attacks of certain insects.

At the Illinois experiment stations it was found in 1934 that a local variety of ordinary open-pollinated corn subjected to a heavy chinch bug attack yielded 12.6 bushels of damaged corn and 31.1 bushels of sound corn, whereas a similar plot of hybrid corn in the same field at the same time yielded 4.8 bushels of damaged corn and 69.0 bushels of sound corn.

R. H. Pettit

The European corn borer, a damaging pest when uncontrolled. Complete coverage of cornstalks and stubble with soil is effective.

Some progress is also being made in breeding corn resistant to the corn borer.

Another method of avoiding insect injury is to plant crops which are not susceptible to the attacks of certain insects. Chinch bugs, for instance, do not injure plants belonging to the legume family; they confine their attacks largely to crops belonging to the grass family.

Some insect injury may be avoided by giving attention to the order in which crops succeed one another. Corn and potatoes are subject to attack by the wire worm. To avoid trouble, do not plant these crops in a rotation following a sod crop, since wire worms tend to establish themselves in sod land. The same holds true for the white grub which is the larval stage of the June bug or May beetle.

Information on Insect Control. Because of the great number of insects of economic importance and the numerous specific conditions of insect damage and control, it is impossible to include in this chapter all the information needed for the effective control of insects. Secure from the state college of

Insects Damaging Crop Plants

Insect	Description	Control
Chinch bug	Soft-bodied bug. Black with white wings with spot on them. The young or nymphs do not fly but crawl from place to place. Sucks plant juices. Particularly injurious to corn.	Protect crops by constructing barriers which the insects cannot cross.
Colorado potato beetle	Adults are large yellow beetles with black stripes. The larva is soft, reddish in color with black spots on sides. Eats foliage of potatoes chiefly.	Spray or dust with calcium or lead arsenate or DDT.
Cotton boll weevil	Adult is yellowish to almost black beetle with snout. Larva is a curved, wrinkled, white grub with a brown head. Grubs feed inside bolls or squares of cotton.	Practice clean culture. Grow early varieties. Dust with calcium arsenate.
Cutworms	The adult is a moth. The larva is a fleshy brownish to grayish worm which cuts off plants at the surface of the ground. Hides in soil during the day.	Use poisoned bran mash when worms appear.
European corn borer	Larva has a cream-colored body with light-brown markings and dark-brown head. The adult is a yellowish brown moth. Worms burrow through stalks and ears.	Destroy stubble. Ensile or shred stover. Destroy weeds. Dust with DDT.
Granary weevil	The adult is a brown beetle. The larva is whitish in color, short, and fat. Adults and larva eat grain.	May be destroyed by fumigating with such materials as cyanide compounds, carbon disulphide, and carbon tetrachloride.
Grasshoppers	Eat foliage. Plants stripped if grasshoppers are numerous.	Use poison bait when grasshoppers appear. Rotation of crops and soil cultivation tend to hold them in check.
Hessian fly	A mosquito-like fly which passes the winter as a larva inside its puparium (looks like flax seed). In spring the larva pupate and finally produce adults. The adults lay eggs which produce maggots that destroy the wheat.	Delay planting winter wheat until after the fly-free date in the fall.
Corn root worm	Adult is a green beetle. The larva is a thread-like yellow-white worm about one-half inch long, having a brown head and thorax. Bores into cornstalks near ground surface destroying roots.	Follow crop rotation system. Do not plant corn on ground occupied by corn the previous year.

agriculture and experiment station the bulletins which deal with the control of insects that are of local importance. The chart on page 259 provides information about some of the more important insects attacking crops.

SUGGESTIONS

1. Secure bulletins from the state agricultural college giving information about the control of insects that are important in local communities.

2. Secure specimens of the insects that are of local importance. Many specimens may be obtained by teachers and students during summer months to be used for classroom purposes during the school year.

3. Make a list of the insects that are known to cause important losses of crops in the local community. Study each insect to determine its characteristics. Decide upon the recommended practices to be followed in controlling each insect that may be expected to cause difficulty.

4. Place on display a number of insect specimens or pictures of the insects without names attached and try to name them.

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CHAPTER XVII

CONTROLLING WEEDS

Weeds are plants having undesirable characteristics of manner, time, or place of growth. Much of the farmer's time is given to problems having to do with the control or eradication of such plants. Weeds are a continual menace to efficient farming. In many instances careless farmers have permitted their farms to become so thoroughly infested with weeds that it is impossible to carry on profitable crop production. Whole fields and sometimes whole farms have been lost to weeds such as perennial sow thistle, quack grass, Canada thistle, and field bindweed. When they become thoroughly established, it is an expensive process to rid the land of them so that crops may be raised successfully.

Essential operations and items of information in weed control are as follows:

1. Damage caused by weeds.
2. Types of weeds and manner of growth.
3. Preventing weeds from becoming established upon farms.
4. Destroying weeds by cultivation.
5. Cutting and pulling weeds.
6. Controlling weeds by rotating crops.
7. Smothering weed growth.
8. Spraying to destroy weeds.
9. Noxious weeds.

Damage Caused by Weeds. The damage caused by weeds may be enumerated under several headings.

1. Weed plants in making their growth rob plants of moisture, plant food, and light.

2. Weeds increase the cost of growing crops. Certain practices such as cultivation must be performed in order to control weeds. Time, power, and equipment have to be devoted to the problem of preventing weed growth.

3. Weeds decrease the value of land. The value of a farm may be affected not only by the fact that weeds prevent good crop production but also by the fact that weeds are unsightly.

4. Grain or forage crops containing weed seeds or weed plants sell for a lower price than such crops free of weeds.

5. The value of wool is often reduced because the burs of various weed plants become so entangled in the wool fibers that it is very difficult, even impossible, to remove them.

6. The presence of certain weeds in pastures may result in the production of poor-flavored milk and milk products. When cows consume wild garlic the milk and butter produced have an undesirable taste and a low market value.

7. Some weed plants are poisonous to man and to livestock. The pollen of certain plants causes a catarrhal affection known as hay fever. Water hemlock, loco plants, lupines, and tall larkspur are examples of plants poisonous to livestock.

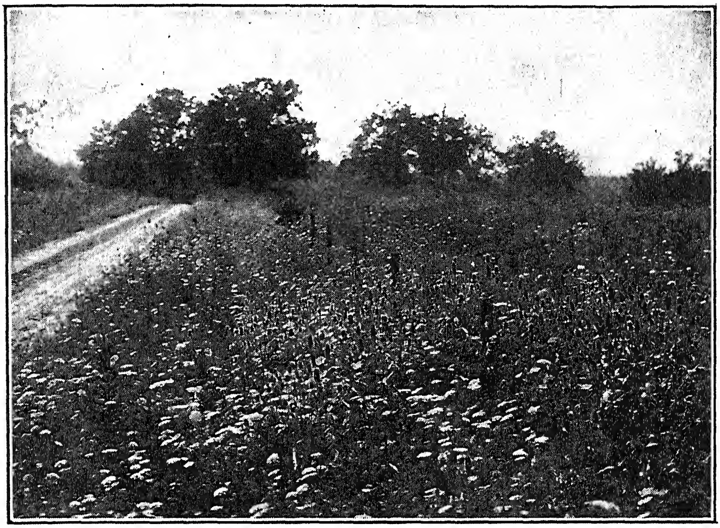
8. The seeds of some plants remain alive in the soil for years; consequently it takes many years before such weeds can be eradicated once the soil has become infested. The seeds of wild mustard live for long periods and germinate whenever conditions become favorable.

Types of Weeds and Manner of Growth. Farmers should understand the growing habits of the weeds which they desire to control. Such knowledge is useful in the planning of the best methods of weed control for, otherwise, time and money may be wasted in ineffective methods.

Annual Weeds. These weeds complete their life cycle from germinating seed to seed production in one year or growing season. The essential procedures to follow in controlling annual weeds are the prevention of the seed from getting into the soil with the crop seed, the destroying of weed growth by methods of seed-bed preparation and cultivation, and the cutting of such weeds early enough to prevent seed formation and late

enough to prevent plants from developing new growth which will bear seed.

Biennial Weeds. Such weeds use two years, or growing seasons, to complete their life cycles, from germinating seed to seed production. During the first season they produce a rather



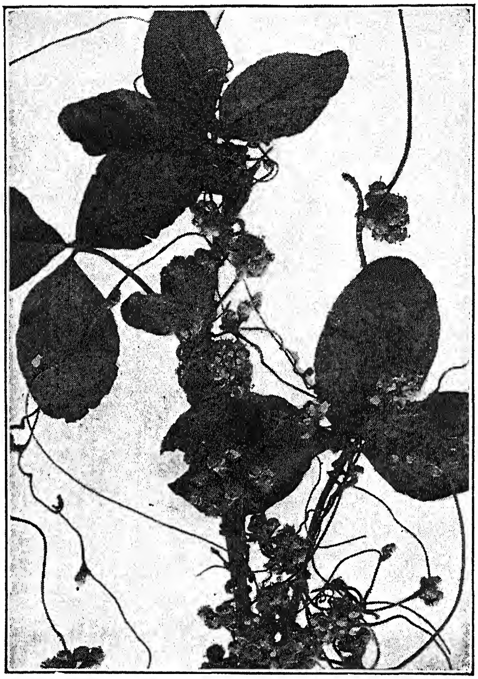
Purdue Univ.

Crops cannot be efficiently produced in neighborhoods overrun by weeds.

abundant leafy growth. The products manufactured by the plant during the first growing season are stored in roots, underground stems, or some other portion of the plant. At the beginning of the second growing season, the new plant starts, not from seed, but from the portion of the plant left from the previous year. The material stored during the previous growing season starts the plant for the second growing season. At the end of the second growing season, seed is produced.

Biennial plants may be controlled by cultivating or cutting to prevent the formation of seed or by destroying the first season's growth.

Perennial Weeds. Perennial weeds are weed plants which grow continuously year after year for an indefinite length of time. During each growing season such plants generally per-



Dodder often seriously injures clover in the Corn Belt and Southern and Western States.

form two functions. One is to store sufficient plant food in underground roots or stems to enable the plant to live and grow from growing season to growing season. The other is to produce seeds which are spread about by various means. In dealing with such weeds farmers have not only the task of preventing the spread of the plant by its underground roots or stems, surface runners, or stolons but also the problem of

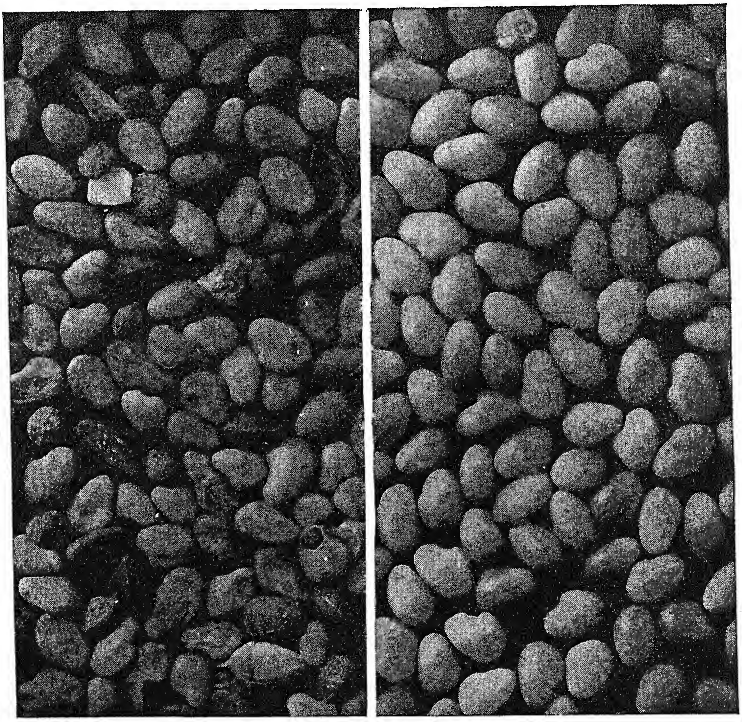
keeping the plants from producing seeds which tend to spread the plant over large areas.

The Canada thistle is an excellent example of a harmful perennial weed. The plants have vertical roots running deep into the soil. From the vertical roots horizontal roots grow from the parent plant. At intervals along the horizontal underground roots vertical growths develop which push up to the surface of the soil to form new plants. During the growing season enough plant food is stored in such roots to carry the plant through the winter or a dormant period and to start the plant for the next growing season. In addition there is produced each season a quantity of seed which enables new patches of the thistle to start wherever the seed may chance to be placed under suitable growing conditions.

The method of controlling perennial weeds will be considered in the section on control method (page 268).

Preventing Weeds from Becoming Established on Farms. The best plan is to prevent weeds from becoming established on a farm in so far as is possible. The problem of controlling weeds has become so serious that most states have laws relating to weed control. Farmers should respect these laws and learn to use them to the greatest possible extent to protect themselves from weed damage. The provisions of the weed laws should be studied as they apply to a given locality. The laws generally name certain especially bad or noxious weeds and also contain provisions dealing with the prevention of the spread of such weeds. Most laws contain provisions safeguarding the purity of farm seeds offered for sale within a state. People having seed for sale are required to send samples of the seed to a state seed laboratory for analysis. In such laboratories the samples of seed are examined for purity and germination. When the seed dealer, or person having seed for sale, receives the report he is usually required to place on the seed containers tags which give the results of the analysis made by the state seed laboratory. It is important to understand the information on the tags. Usually the tag

states the amount of weed seed present and the names of noxious weeds that are present. In addition, the tags give information on the germinating quality or viability of the



Seed of clover, alfalfa, and sweet clover as it comes from the thresher carries a high percentage of immature seed, weed seed, and dirt. This seed must be cleaned thoroughly with the right kind of seed-cleaning machinery before it is fit for commercial distribution. The above shows a sample of red clover seed before and after cleaning.

seed and the amount of trash or foreign matter found in it. In many states seed which shows the presence of noxious weed seeds above certain low limits cannot be sold within the state.

It is very important for farmers to understand the provi-

sions of the weed laws and to cooperate in making them effective.

Much can be done in preventing weed seeds from getting to the fields by cleaning crop seeds thoroughly before planting. Excellent seed-cleaning machinery is available and should be used.

When threshing machines are moved from farm to farm, great numbers of weed seeds may be carried from place to place. Farmers should cooperate in the control of weeds by aiding the threshermen to clean the separator thoroughly before it is moved to the next farm.

Weeds often find their way to the soils of farms in feeds containing weed seeds. It is important to see that such feeds are free from noxious weed seed, especially. If mill feeds containing screenings are to be fed, it is important to see that they are ground fine enough to destroy the weed seeds.

In many instances weed seeds will pass through the digestive systems of farm animals without having their germinating ability destroyed. In the feeding process weed seeds get into the manure and go with the manure to the land. Consequently it is important to use feeds which are as free from weed seeds as possible.

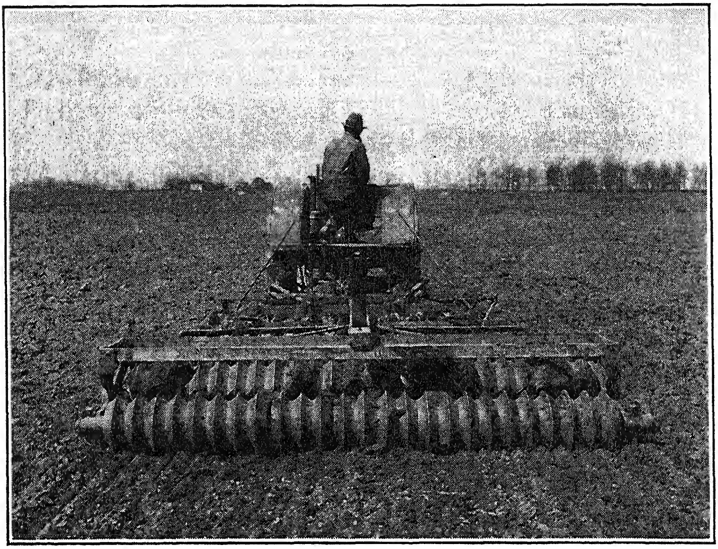
Any weed seeds which happen to be put into a silo will lose their power to grow because of the process of fermentation which goes on in a silo.

Several methods may be used to eradicate weeds after they have become established or have started to grow.

Destroying Weeds by Cultivation. An excellent method to use in destroying large numbers of weeds is to prepare the seed bed before the crop is planted. The working of the soil helps to warm it up and starts the germination of the weed seeds. Reworking the seed bed after a short time, in final preparation for the planting of the crop, destroys the weeds that have started. If a weeder or smoothing harrow is used before the crop is up and, in many instances, after the crop is up, great numbers of weeds will be destroyed. In inter-

tilled crops, cultivation should be continued as long as it is possible and there is need for destroying weeds.

When such noxious perennial weeds as quack grass, Canada thistle, and perennial sow thistle have become established, it may be necessary to forego raising a crop and to keep such



U.S.D.A.

Preparing a thoroughly fitted seed bed lessens cost of weed control.

land or patches under continuous cultivation until the weeds have been destroyed. When it is necessary to attack weed growth in this way, it is important to cultivate the soil often enough to keep the plants from making any green growth. If green growth is prevented, the plants are forced to use their stores of plant food in trying to make growth with no opportunity to manufacture new material to be used in growth. It is important to understand the nature of plants and how they feed and grow in order to decide upon the best methods of eradication.

In a weed such as quack grass, it is especially important to see that the process of cultivation does not carry pieces of the underground stems to clean soil, since such pieces easily take root in new locations.

Cutting and Pulling Weeds. When it is essential to prevent the formation of seed, weeds may be cut before the seed begins to form. If there are many weeds, the cutting should be delayed until the plants are coming into bloom. This is early enough in most cases to prevent seed formation and late enough to prevent the weed from making new growth that will bear seeds.

In small patches of certain types of weeds, the plants may be pulled when the ground is moist.

Controlling Weeds by Rotating Crops. Many weeds cannot become firmly established if a good system of crop rotation is used. If the rotation includes a sod, it will be found that great numbers of weed plants do not make much growth in sod land. Certain weeds which do well in sod land are destroyed when the land is plowed. If the rotation includes an intertilled crop and a good system of cultivation is practiced, weeds have little chance to grow.

If the soil in the rotation is kept fertile enough to produce a vigorous crop growth and if good practices are followed in giving the crops an advantage over the weeds, weeds have little chance.

Smothering Weed Growth. When small patches of noxious weeds are found on a farm, it may be profitable to cover such areas with tar paper or cheap roofing. Any weeds kept under such a cover for a growing season will probably be destroyed. When large patches or fields of weed have become established, it is often advisable to cultivate for part of a season and to plant some quick-growing dense crop which will tend to smother the weed growth.

Alfalfa has been used successfully to destroy Canada thistle. When such a plan is followed, it is usually the practice to weaken the weed growth by cultivation during a growing sea-

son. If the soil is well adapted to alfalfa or has been made so, a good stand of alfalfa can be obtained by the usual practices. If a good stand of alfalfa is obtained, the heavy growth of the crop, plus two or more cuttings during a growing season, will hold in check or kill any Canada thistle plants not killed in the cultivation of the land before the alfalfa was established.

Spraying to Destroy Weeds. Successful methods of killing weeds have been developed by the application of certain chemicals. When such methods are used, it is important to follow carefully the directions for using the materials. Bulletins may be obtained from the various agricultural colleges explaining in detail the procedures to follow. It is very important to follow directions exactly for the use of the many chemicals now available for killing plants. If used with care excellent results may be obtained. Great damage may result, however, if the right procedures are not used.

Weeds may be killed by applications of salt or waste oils from garages or other sources. The soil, however, cannot be used for crop production for a long time after such weed killers are used. Machines and methods for destroying weeds by burning have been developed and are increasing in use.

Iron sulphate, sodium chlorate, ammonium sulfamate, sulfuric acid spray, ammonium thiocyanate, calcium cyanamide or ures, dinitro compounds, oil sprays, and carbon disulphide have been found useful for destroying weeds. Directions for using these chemicals should be obtained from the agricultural colleges and experiment stations.

A weed killer is now available which stimulates plant growth to such an extent that the plants are destroyed. It is called dichlorophenoxyacetic acid or 2,4-D. This material kills certain weeds without destroying crops. Excellent results are being secured in killing weeds on an extensive scale with 2,4-D.

Noxious Weeds. The following are some of the weeds which are particularly bad and are therefore called noxious weeds: Canada thistle; field bindweed or European morning glory;

hoary cress, whitetop, or perennial peppergrass; horse nettle; leafy spurge; perennial sow thistle; Russian knapweed; quack grass; wild carrot; buckhorn; dodder.

SUGGESTIONS

1. In most states the state college of agriculture has bulletins dealing with the particular weeds causing the greatest difficulty. Secure these publications.

2. Secure from your state department of agriculture copies of the weed laws which pertain to the state. Make a study of these laws in order to be familiar with their provisions.

3. When purchasing seed of farm crops note the statements made regarding the purity of the seed.

4. If seed-cleaning machinery is available, use it in cleaning various farm seeds in order to learn the correct adjustments.

5. During field trips, in the fall of the year especially, secure specimens of weeds and weed seeds to be used for classroom study.

6. If patches or fields of troublesome weeds are found on farms, plan specific programs for control or eradication.

7. Carry out demonstrations of chemical or other effective means of weed control.

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Cox, J. F., and L. E. Jackson, *Field Crops and Land Use,* John Wiley and Sons, 1942, Chapter XI.

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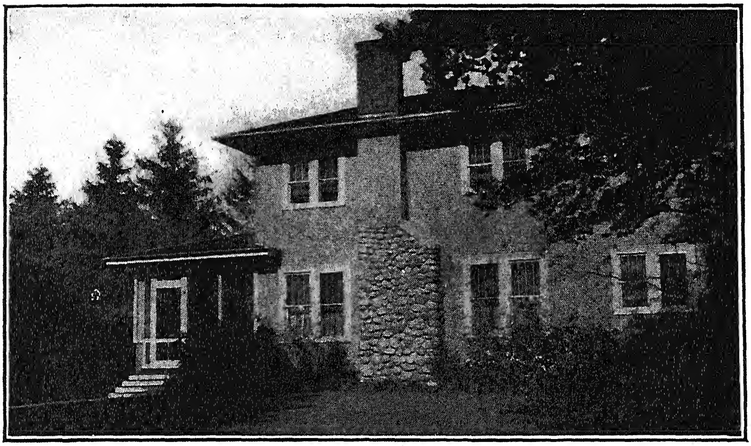
CHAPTER XVIII

PLANNING IMPROVEMENTS IN CROP-MANAGEMENT AND SOIL-CONSERVATION PROGRAMS FOR SPECIFIC FARMS

The value of a knowledge of principles in crop management and soil conservation lies in their effective application to the improvement of specific farming programs. If the foregoing chapters of this book have served their purpose, each student should have a broader understanding of basic information related to agriculture, a clearer conception of fundamental principles applicable to agriculture, and a comprehensive outlook on the place of agriculture in the national program of social welfare. These chapters do not in themselves contain these outcomes but merely provide a means of guiding the development of them in the minds of students.

The early chapters suggest that students examine their home farm situations by means of surveys and plan supervised practice or project programs to be carried out on home farms. The surveys reveal, and the project and supervised practice programs present, actual farm problems. Various phases of these problems are clarified by the pooling of information from the experiences of students, farmers, and teachers, and the supply of information found in reference books, bulletins, and this text. Class discussions of farm problems in the light of the growth and the maturity of crop plants, the nature of soils, soil-conservation plans, fertilizing, liming, manuring, improving crop varieties, growing crops in rotation, controlling plant diseases, and other important phases of agricultural knowledge should develop in each individual an improved ability to adjust himself to the ever-changing demands of modern farming.

Selecting Crop Enterprises and Crop and Soil Management Practices for Home Farms. The student should make a selection of the specific crop enterprises and crop and soil management practices to be carried out, either as supervised practice or project programs or as part of the regular farming program on home farms. Certain enterprises and practices may have



Careful planning and the balancing of essential operations in the production of crops, maintenance of fertility, breeding and feeding livestock, and marketing farm products underlie the maintenance of the farm home.

been decided upon previously for purposes of project or supervised practice work, but at this point it is important to make final plans for complete programs of crop production and soil management.

It is suggested that each student prepare a list of crop enterprises and crop and soil management practices adapted to the farming program on home farms. The following headings may be used:

A. Crops to be grown primarily as cash crops.
   List those crops which are grown and crops which might well be considered for the farming program.

B. Crops to be grown primarily as feed for livestock.
   1. Grain crops. List the crops which should be continued and also those crops which may be considered for the farming program.
   2. Forage crops:
      a. Regular hay crops.
      b. Emergency hay crops.
      c. Pasture:
         (1) Permanent.
         (2) Rotation.
         (3) Annual or emergency.

   (NOTE. Under the above headings list the crops now grown which should be continued and the new crops which may be introduced or tried out.)

C. Home food and feed crops.
   1. Home garden.
   2. Particular truck crops needed in addition to the ordinary home garden.
   3. Feed for producing livestock and livestock products to be consumed at home.

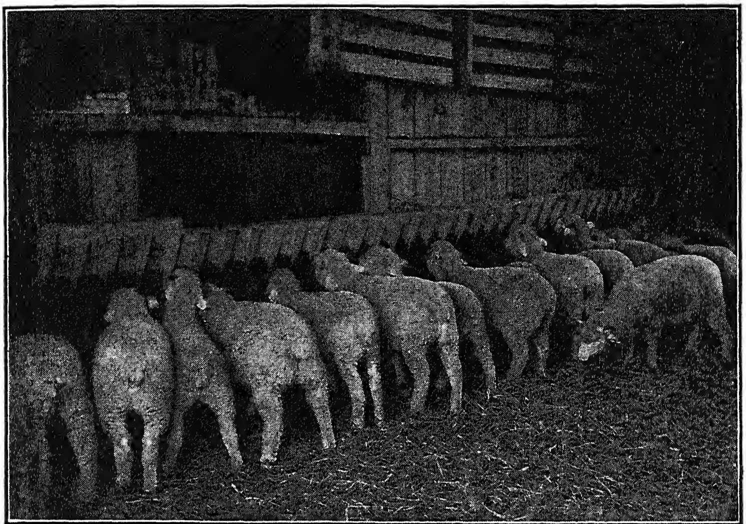
D. Particular opportunities for improvement in the farming program on home farms.
   1. List any particular soil erosion problems which may call for gully control, strip cropping, terracing, or some other form of erosion control.
   2. Indicate any need for the planting of certain areas to trees.
   3. Prepare a liming program needed to improve crop production.
   4. Plan permanent pastures if they present an unusually important problem.
   5. Introduce a new crop or a new practice.

After each student has prepared the information as indicated it is advisable to develop on the blackboard a master list in order to discover the problems which interest most of the members of the class and those problems which concern a few.

By this procedure plans may be made for the whole class to participate in the solving of the problems of general interest

and particular arrangements may be made to help students whose problems are individual in nature.

The master list may be thought of as an outline of the course of instruction to be carried out during the remainder



Alfalfa—Cox and Megee

Crop production plans must be made largely in accordance with the need for livestock feed.

of the school year or period of time to be devoted to crop management and soil conservation.

Determining the Problems to Be Solved. The enterprise of corn growing, for example, cannot be considered one large problem to be solved. The enterprise consists of many phases or parts which present problems. These problems must be discovered by analyzing the enterprise. A simple procedure to follow in finding problems is to divide an enterprise into jobs or job problems. This procedure is commonly called job analysis.

In the corn enterprise, for example, it will be noted that cer-

tain problems center about decisions which have to be made. These may be called *managerial jobs,* or jobs which require the making of managerial decisions. Other problems center about the carrying out of certain operative procedures. These may be called *operative jobs,* or jobs which are completed by carrying out certain operations step by step.

Examples from the corn enterprise:

1. Managerial jobs or those jobs which are chiefly concerned with the making of decisions.
   a. Deciding upon the acreage to be devoted to corn.
   b. Deciding whether or not to use hybrid seed.
   c. Deciding upon the right kind and amount of commercial fertilizer to use.
2. Operative jobs, or those jobs which are primarily concerned with the carrying out of operative steps involving standard or approved practices.
   a. Testing seed corn.
   b. Grading seed corn.
   c. Adjusting the planter.
   d. Operating various machines used in the corn enterprise.

Forms for Making Job Analyses. The following forms illustrate the manner in which analyses may be made of the managerial and operative jobs.

Plan for Using Text and Other Sources of Information. If the suggestions in this chapter are used, it is expected that students and teachers will analyze each enterprise or phase of crop management and soil conservation to be included in the farming programs in which students have an interest. In the corn enterprise, for example, it will be found that, in the making of managerial decisions and in the gaining of skill in operative jobs, information available in Chapter XIX, which deals with corn, may be applied along with the many principles applicable to the problems of corn growing that were developed in the various chapters of Part I. In addition, the many other sources of useful information suggested in connection with the earlier chapters should be used.

Form for Managerial Jobs

Job: (Place in this space a statement of the managerial job requiring a decision.)

Decision (to Be Made)	Factors	Kind of Information Needed for Applying Factors
Place in this column exact statements of the one or more decisions which must be made in relation to the job.	Opposite to the statement of the decision to be made enumerate the factors involves. A factor is a general phase of the situation which has to be considered in arriving at a decision.	Before the factors can be used in arriving at a decision the exact facts to which each factor refers should be determined.

Example

Job: To decide on the crops to be included in a farming program.

Decisions (to Be Made)	Factors	Kind of Information Needed for Applying Factors
What crops to grow	Acres in farm	List acres of tillable and non-tillable land.
	Markets	Determine the market outlets for various farm crops.
	Livestock raised	List the kind of feeds needed for livestock.
	Type of soil	Determine type of soil and crops adapted to it.
	Climate	List facts as to rainfall and average length of growing season.
	Labor	Indicate availability of labor.
	Equipment	Actual equipment available or needed.
	Community trends, etc.	Facts regarding the crop-production program on neighboring farms, etc.

Form for Operative Jobs

Job: (Place in this space an exact statement of the operative job.)

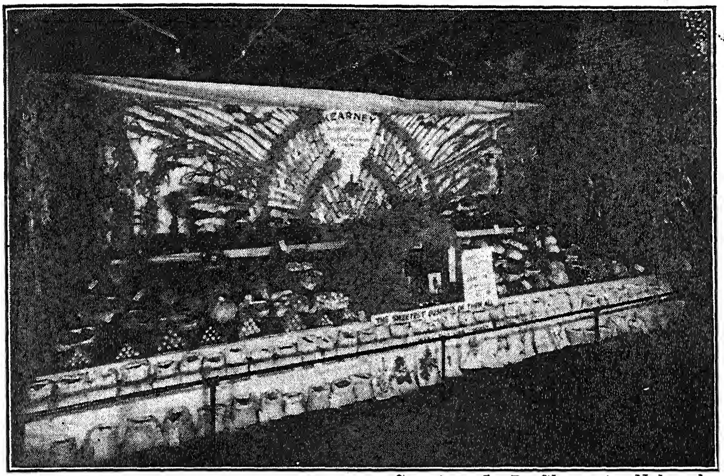
Operations	Standard or Accepted Practice
Place in this column a statement of each actual operation which must be performed to complete the job.	Opposite each operation to be performed, place exact statements of the standard or approved practices to be followed in performing the operation. The practices listed should be those decided upon as most suitable for the specific situation.

It is not expected that every student will use each chapter in Part II of this text. It is assumed that a selection will be made of those chapters containing information that is of use in specific situations.

At the close of a school year devoted to crop management and soil conservation each student should have developed an

Canal Winchester, Ohio

A vocational agricultural class discusses specific enterprises.



Courtesy L. D. Clements, Nebraska

Preparing effective crop exhibits, particularly after harvest time, is a valuable class project.

understanding of the fundamental principles involved and should have actual plans in operation that will lead to distinct achievement in the production of crops and the maintenance of soils.

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United States Department of Agriculture, *Yearbook*, 1943–1947, pp. 905–910.

PART II

CHAPTER XIX

CORN GROWING

Corn produces more food value per acre than any other crop.
H. C. WALLACE

Corn is the world's leading cereal in total weight of harvested crop. The business of corn growing contributes more to the annual increase in the wealth of the United States than that of any other crop. The prosperity of the nation and of individual farmers who grow corn is influenced in a large measure by the success of the corn crop and the price received by the grower. It is to the interest of both the nation and corn growers to utilize, over a wide area, the methods which the most successful producers have found most effective in producing large yields per acre at the cheapest cost per bushel, and to cooperate in planting acreage to corn in accordance with market demands. In states where the corn borer has appeared in numbers, radical changes in methods of growing and feeding corn are necessary to control this pest.

For the years 1919 to 1939 the average yield per acre of corn in the United States was approximately 26½ bushels. Many growers secure three or four times this yield. Greater care on the part of corn growers in choosing hybrid varieties as seed and in better cultural methods has brought about a very considerable increase in total production. During the war years hybrid corn varieties came into general use, and in

1944 the average yield of Iowa reached the amazing average of 54 bushels per acre. In 1944 99.8 per cent of the total acreage of Iowa was in hybrid corn compared to 0.7 per cent in 1933 with an average yield of 34 bushels per acre.

U.S.D.A. Extension Service

Corn is the chief field grain crop grown in the United States. Superior adapted hybrids have markedly increased yields. (Future Farmers demonstration.)

The following operations characterize methods employed by the most efficient corn growers:

1. Choose best hybrid or the highest-yielding, best-adapted standard variety.
2. Select seed corn in the field.
3. Dry seed corn immediately and store in a well-ventilated place.
4. Sort, test, and grade seed corn.
5. Plow corn ground in fall or early spring.

6. Prepare the seed bed thoroughly.
7. Fertilize properly. Manure and acid phosphate are usually most effective.
8. Plant at best time, rate, and depth.
9. Cultivate to kill weeds without pruning corn roots.
10. Harvest when properly matured.
11. Store in well-ventilated cribs.
12. Hog off corn to fatten hogs cheaply.
13. Put in silo for effective feeding to dairy cows, beef cattle, and sheep.

Additional information is concerned with:

1. Growing popcorn.
2. Growing sweet corn.
3. General information.

Numerous varietal tests conducted at experiment stations and local points show that corn varieties differ much in yielding ability and in market quality. Fortunately there are many corn growers in practically all corn-growing sections who have taken great interest in the development of well-adapted and high-yielding strains of corn and who have, by years of careful selection, laid a foundation for the improvement and standardization of corn varieties. Plant breeders of experiment stations in corn-growing districts have gone farther with this work of selection and breeding. *Corn hybrids,* developed by combining the right selfed parent strains, are now available generally and are notably high yielding. They have supplanted the standard open-pollinated varieties in the fields of the best corn growers. The rapid increase in the use of hybrid corn is illustrated by the fact that in 1933 the acreage of hybrid corn was 143,000 or 0.1 per cent of the total corn acreage whereas in 1945 the acreage had increased to 60,347,000 or 64.1 per cent of the total corn acreage.

Professor R. D. Lewis and G. H. Stringfield of Ohio State University Extension Service write the following in regard to this modern method of corn breeding:

Selection within selfed-fertilized lines involves three main steps: (1) The isolation or fixing of pure-breeding strains of corn (inbred lines) by at least five generations of inbreeding with selection; (2) the testing of the selected inbred lines to determine which ones possess desirable hereditary qualities for yield, quality, strength of stalk, resistance to disease, resistance to drouth, etc., and (3) the combining of superior inbred lines into desirable hybrid combinations.

For producing corn hybrids then, only pure-breeding strains (inbred lines) are used, and they are combined by *controlled pollination* into the following types of hybrids:

1. *Single Cross.* The first generation of a hybrid between two inbred lines (B x A).
2. *Double Cross.* The first generation of a hybrid between two single crosses (B x A) x (C x D).
3. *Three-Way Cross.* The first generation of a hybrid between a single cross and an inbred line (B x A) x C.

The single cross is also known as a foundation hybrid, for you will note that it is used in producing double crosses, which are types of hybrid seed generally purchased for planting fields to be harvested for feed or commercial use.

Comparative Characteristics of Hybrids and Open-Pollinated Varieties

Why do adapted hybrids have this greater ability to yield? No one characteristic is altogether responsible. Such hybrids are uniformly more vigorous in growth and production than the ordinary varieties; they have a higher proportion of strong leafy, deep green plants; fewer nubbins and barren stalks; during storms they resist lodging and breaking of plants; they have stronger root systems; during dry weather they are less affected than the ordinary varieties, and generally they are less subject to smut. In brief, the hybrids produce uniformly better plants.

Fewer Barren Stalks

Again we turn to actual results. In 307 farm comparisons, the hybrids were reported by farmers as having decidedly fewer barren

stalks in all but three instances. Counts in the yield test at Holgate in Henry County in 1933 showed that the five best hybrids averaged 96 ears for each 100 plants, while the five highest-yielding varieties had only 86 ears for each 100 plants.

Stronger Plants

The stiffer stalks of most hybrids are both a revelation and a relief from many of the trials and tribulations of corn cutting and husking. For instance, in 97 per cent of the farm tests of 1935, the hybrids were reported as being stiffer stalked. At the Experiment Station at Wooster in 1933, a severe storm in August caused most of the corn to break over badly. The four stiffest stalked varieties in the comparative tests had an average of 53 per cent of lodged plants, yet four high-yielding hybrids averaged less than one-fifth as many lodged plants. In the fall of 1935, one user of hybrid seed reported that the corn cutters made over twice as much money per day in his fields as in adjacent fields with badly lodged corn. Stiff stalks help to produce greater yields and to reduce harvest and husking costs.[1]

Standard Corn Belt Varieties. It would be unnecessary and impossible to list and describe the 2000 or more corn varieties grown throughout corn-growing regions. The following are recognized as parent varieties from which many others have been developed, and which are leading varieties over broad areas.

Leading Corn Belt Varieties [2]

Northern Corn Belt	Silver King, Golden Glow, Northwestern Dent
Central Corn Belt	Reid's Yellow Dent, Leaming, Boone County White
Southern Corn Belt	Reid's Yellow Dent, Boone County White, St. Charles White

[1] From *Corn Hybrids in Ohio,* by R. D. Lewis and G. H. Stringfield.

[2] For a more complete list with description, see *Corn and Corn Growing,* by H. A. Wallace and E. N. Bressman, John Wiley & Sons, Inc., 4th ed., 1937.

Reid's Yellow Dent. This is recognized as a leading variety for the rich soils of the Corn Belt. Many other strains, such as the Iodent in Iowa and the Pickett in Michigan, have been developed from it by selection. Reid's yellow dent was developed by James L. Reid in northern Illinois from a hybrid of the Gordon Hopkins variety brought by his father from Brown County, Ohio, in 1846. This variety, a large, reddish corn, proved to be late in maturing and was crossed the next year when it was replanted with a smaller and earlier yellow dent corn. From this hybrid the modern Reid was developed. In the Reid and the Pickett, a northern selection, the reddish color of the original Hopkins is frequently noticeable at the sides of the kernels.

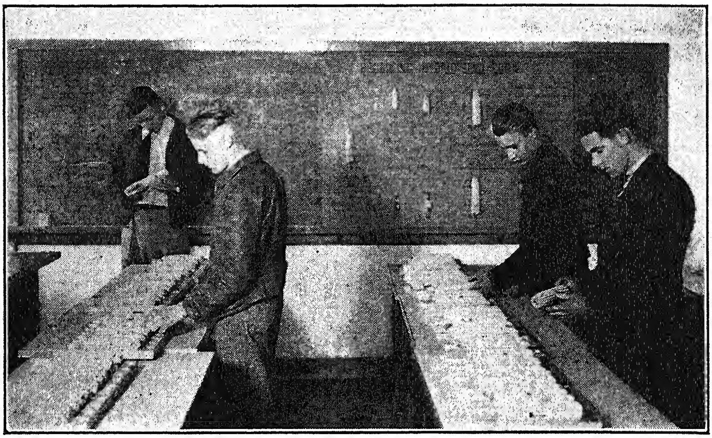
Reid's yellow dent is one of the outstanding leaders of corn-yield contests and corn shows. It is extremely uniform and cylindrical in shape, with slight taper, and deep, keystone-shaped, large-germed kernels. The butts and tips are well covered, and the cob is small. The color is a rich yellow. This variety requires from 110 to 120 days to mature. The ears are 9 to 10 inches long and 7 to 7½ inches in circumference.

A monument has recently been erected by national subscription to the late James L. Reid for his service to the nation in developing a variety which has added millions of dollars to the value of the corn crop.

Leaming Yellow Dent. This is the oldest and one of the most widely grown varieties of the Corn Belt. It was developed in 1856 by J. S. Leaming, in Champaign County, Ohio, from stock brought north by him when he moved from Hamilton County in southwestern Ohio. This original stock was very probably brought from Virginia, when that district was settled as part of the Virginia Land Grant. Mr. Leaming selected his seed in the field from vigorous stalks of early maturity. This variety is marked by strongly tapering ears, large butts, usually smoothly indented kernels, and deep yellow color. The Leaming of the southern Corn Belt is larger with a rougher indentation. Many varieties have been developed

from it by selection. The ears average 9 to 10 inches in length and 7 to 7¾ inches in circumference, and require a growing season of 110 to 120 days for full maturity.

Boone County White. This variety was developed in Boone County, northwestern Indiana, by James Riley, from a selection made in 1876 from the white Mastodon. The stalk is



Courtesy of L. D. Clements, Nebraska

A vocational agriculture class in corn judging. Seed condition, type, varietal characteristics, and freedom from disease are important points considered.

heavily leaved and vigorous. The ears range from 9 to 11 inches in size and 7½ to 8 inches in circumference. The ear is cylindrical in shape with straight rows and is uniform. This variety requires 120 to 125 days to ripen. The Johnson County White is very similar, and in many localities the name Johnson has been discarded in favor of Boone.

The Boone County white is the most widely grown white variety of the Corn Belt.

St. Charles White. This is an old variety of St. Charles County, Missouri. It requires 125 to 130 days to ripen and makes a rank stalk growth. The ears are large, 10 to 11½

inches, taper strongly and have a blood-red, very distinctive cob.

Silver King. This is a white dent which was developed at Fort Atkinson, Iowa, from seed brought from Indiana, in 1862, by H. J. Goddard. He practiced field seed selection in the fall, selecting large ears with deep wide kernels borne on small cobs. The ears require from 100 to 110 days to mature and range from 8 to 9 inches in length and 6¾ to 7½ inches in circumference.

The Wisconsin No. 7 is a selection of this variety.

Minnesota 13. This variety was originated by the Minnesota Experiment Station in 1893. It is an early variety, maturing in 100 to 110 days. The ears are 7 to 8 inches long, smoothly indented, with 12 to 16 rows of kernels.

Golden Glow. This variety was developed at the Wisconsin Experiment Station from the Minnesota 13 and a local yellow dent variety. It is a leading variety in northern corn-growing regions. It is early, requiring only 90 to 110 days to ripen. The ears are a golden yellow color, with smooth indentation, and range from 6½ to 8 inches in length, carrying 14 to 16 rows of kernels.

Northwestern Dent. This is a hardy, short-seasoned variety. It has red kernels with a white or yellowish crown and ears from 6 to 9 inches in length.

The indentation is smooth, the crowns of the kernels often being flinty in nature.

The flint varieties are earliest in maturing, and are grown farther north and at high altitudes. The stalks are shorter and the ears longer than those of the dent varieties. The kernels have flinty crowns. The smut nose, King Philip, Longfellow, Hall's Golden Nugget, and Mercer are leading varieties.

Hybrid Corn. This remarkable contribution by plant breeders was made possible by recent developments in the science of genetics. Hybrid seed corn is the first generation cross involving two or more inbred strains of corn. Its use frequently adds 20 bushels or more per acre to corn yields. Hybrid seed

production should be directed by skilled plant geneticists. Many farmers of crop-improvement associations and seed-corn distributors are now producing hybrid corn under such direction. The high yields are maintained for the first generation only, and seed taken from a field of hybrid corn will yield

Canal Winchester, Ohio

Seed corn placed on racks cures properly and keeps in good condition. Testing the germination of individual ears in a high school department of vocational agriculture.

less. A full discussion of hybrid seed is given in Chapter IX.

Dry Seed Corn Immediately and Store in a Well-Ventilated Place. Good seed corn can be secured only by thoroughly drying carefully selected ears, selected in the fall before they are exposed to freezing weather. In late September and during October corn as it comes from the field contains from 25 to 35 per cent moisture. In this condition it is easily damaged by molding and freezing. To retain its vitality it must be

dried rapidly so that it may pass through the winter with a moisture content of 12 to 15 per cent.

Immediately after harvest, corn for seed should be placed where it will receive free ventilation in order to dry rapidly. No two ears should be allowed to touch. Many excellent devices for drying and curing seed corn are in common use. The ears may be strung on binder twine and hung from a rafter. Wire racks on which the ears are impaled may be made from welded wire fences or they may be purchased. Racks upon which to lay the ears may be easily constructed from two-by-fours and laths. These racks should be placed in the attic or spare room in the house or tool room. A well-ventilated room is necessary. A cellar without furnace is, as a rule, a poor place to store seed corn. During the early period of drying all windows should be opened to remove excess moisture.

Corn properly dried will not be greatly damaged by freezing, but it is best to store where it will not be exposed to extreme cold.

If large amounts of seed are to be handled, special corn-drying houses are desirable. These should be equipped with numerous windows or panels, which will give free circulation of air, and a stove to furnish artificial heat to hasten drying and prevent freezing. Hybrid seed corn is produced by specially trained and equipped seed growers, and farmers generally buy their hybrid seed corn from companies or seed growers of known dependability.

Sort, Test, and Grade Seed Corn. The stand of corn, or number of plants per acre, depends mainly on the germination of the seed planted. It costs as much to cultivate an empty hill as a full one.

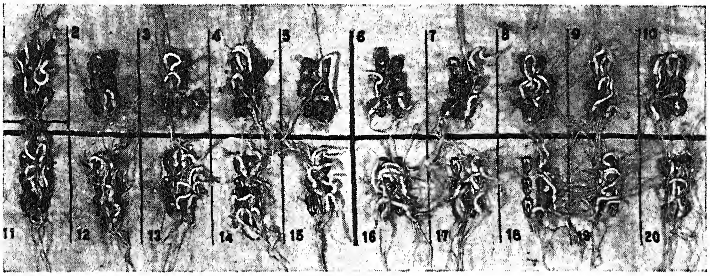
If seed has been properly selected and stored, it should carry through the winter and test 95 per cent or better in the spring.

Seed ears should be sorted carefully, and off-type ears, discolored ears, and ears showing mold should be discarded.

Comparatively few farmers have been producing their own seed since the hybrid varieties became generally available but those who do should test individual ears with a rag-doll tester or a sawdust-box tester.

Hybrid seed generally is accompanied by a statement of germination percentage and is shelled and graded for distribution.

Grading seed corn to uniform sizes insures a more uniform drop in planting. Irregular kernels should be removed at

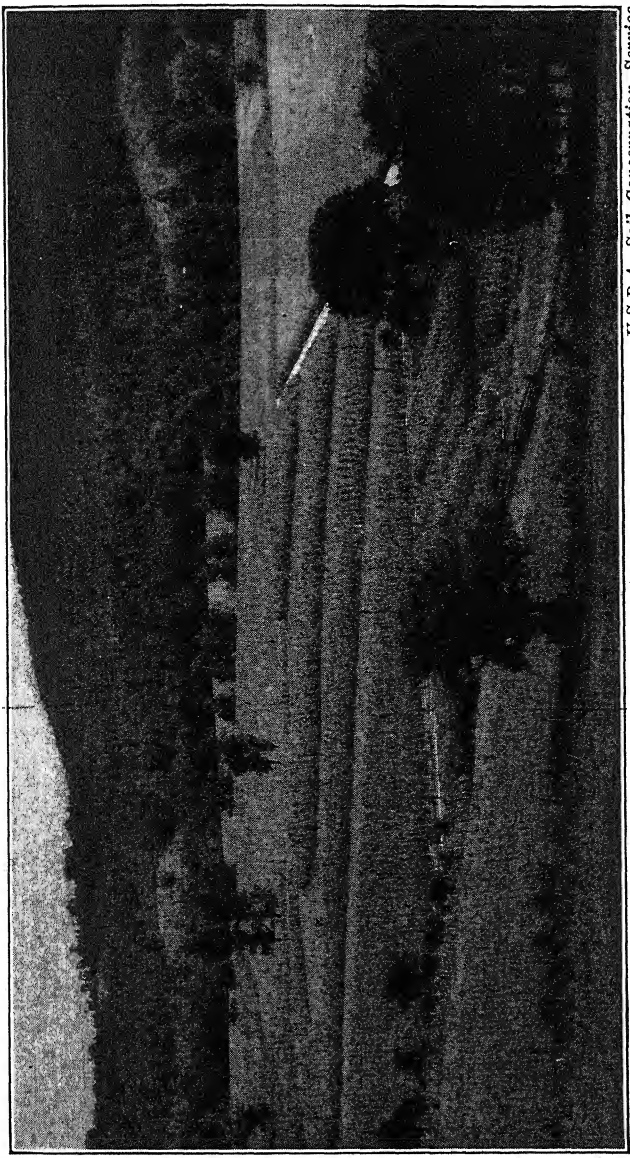


A rag-doll test opened for reading. Strong vigorous sprouts indicate desirable ears for seed. Ears numbered to correspond with spaces showing dead or weak sprouts are discarded.

butts and tips of ears by shelling and discarding, and shelled corn should be graded through hand or machine grader. Sizes should be separated, and the planter plates best suited to the size being planted should be planted.

Plow Corn Ground in the Fall or Early Spring.[3] Fall plowing or early spring plowing, to a depth of 7 inches or more, is the best beginning for a good seed bed for corn. Frequently the gain in crop yields resulting from early and deep plowing in fall or early spring, as compared to late spring plowing, is sufficient to offset the entire cost of plowing. Moisture is retained, the seed bed settles firmly, and insects are largely controlled when land is plowed in the fall.

[3] Secure U. S. Department of Agriculture *Farmers' Bulletin* 1562 for full discussion of farm practices under corn-borer conditions.



U.S.D.A. Soil Conservation Service

Improved yields of corn are secured under a program of strip cropping on contours, rotation with legumes and small grains, and adequate fertilizer and lime applications.

Fall-plowed land should be allowed to go through the winter in the rough, that is, as turned. In this condition it catches and holds snow and absorbs rain. In the spring, as soon as it is in condition to be worked, fitting with disk or spring-tooth harrow should begin. Early spring plowing should be followed by roller and harrow.

It is usual to plant corn after sod and to apply manure before plowing. Sod land is generally more easily prepared in the fall and early spring. The early plowing gives time for the thorough incorporation of the sod and manure with the soil. Corn planted on land prepared late in the spring is much more liable to injury from drought, insects, and weeds.

When it is necessary to plow late in the spring for corn, the ground should be very thoroughly rolled to compact firmly. The rolling should be followed by thorough and frequent disking and harrowing.

Prepare the Seed Bed Thoroughly. The thorough preparation of the seed bed for corn saves labor in later cultivations and increases the yield. Weeds can be most economically controlled at this time, and a great saving is accomplished in the time and expense necessary to control weeds after the crop is planted. Harrowing or disking and using the rotary hoe before planting are much less costly methods of weed control than cultivating between the rows. Weeds are most effectively controlled if sprouting weed seeds are disturbed when the germinating sprout is "in the white" or when weed plants are exceedingly small. In times of high labor cost, thorough preparation before planting is an important step toward economy of production.

A good seed bed for corn should be well settled at the bottom of the furrow slice, and at the surface should approach, as nearly as possible, the condition known as garden tilth.

When the seed bed is being fitted for corn, fall-plowed ground is usually fitted by being disked in early spring in the same direction as the furrows. After disking, the spike-tooth harrow, spring-tooth harrow, or rotary hoe is used at intervals of

a week or ten days until planting time. Final fitting before planting is effectively made with the cultipacker.

Spring plowing should be done as early as possible in the spring, and the furrow slices immediately compacted by the cultipacker. After the cultipacker, the disk harrow is generally employed, and the ground is worked at intervals of several days to a week with the spike-tooth or spring-tooth harrow or rotary hoe. A cultipacking just before planting puts most soils in best condition for the drilling of the seed.

Fertilize Properly—Manure and Acid Phosphate Usually Most Effective. Corn makes excellent use of manure. Applications of 6 or 8 tons of manure before plowing or during preparation of the land result in a marked increase in yield. The use of acid phosphate, or a fertilizer high in phosphorus, in connection with manure, results in a further increase in the yield and noticeably hastens maturity. The application of 200 or 300 pounds of acid phosphate, or of a commercial fertilizer high in phosphorus, is recommended.

On light or badly run land, a complete fertilizer, such as a 4–12–4 or a 2–12–4, carrying nitrogen, phosphorus, and potash, may give good returns.

On muck soils, fertilizers high in potash and phosphorus are necessary for continued success with corn.

Best results are secured from fertilizer by applying broadcast when fitting the seed bed. An amount of more than 150 pounds per acre, drilled in the rows, may cause concentration of corn roots close under the hill, or injure sprouting seed; the crop is then left in poor condition to withstand periods of drought. On light soil, when planting is late under dry conditions, the use of not more than half this amount may be advisable. Two or more methods of application are often used on some crops.

Plant at the Best Time, Rate, and Depth. Corn is usually planted about the middle of May in the greater part of the Corn Belt. Planting time may begin in early May in the

lower part of the Corn Belt whereas, in the northern corn-growing regions, corn growers usually plant in late May or early June.

U.S.D.A.

The date for planting corn as shown above varies with latitude and altitude.

Planting fairly early in the season, if the seed bed is in good condition, generally gives the best results.

The best time to plant corn varies also with individual seasons; hence, the old sign of the Indians for a safe planting time, "when the leaves of the white oak are the size of squir-

rels' ears," can be taken as an excellent guide. Long years of observation have proved the dependability of this Indian sign.

In the Corn Belt, corn is usually planted at the rate of 3 kernels per hill, in rows 3 feet 6 inches apart, by means of a check-row drill. In more northerly regions, 4 kernels are planted per hill. Checking permits cultivation both ways, and controls weeds more effectively. If drilled in rows, corn is dropped every 12 or 14 inches in rows 42 inches apart in the Corn Belt and 36 inches apart in northern regions.

Corn for ensilage may be planted somewhat thicker, kernels being dropped every 9 or 10 inches in rows 38 or 42 inches apart. One bushel of seed corn will plant 6 to 8 acres.

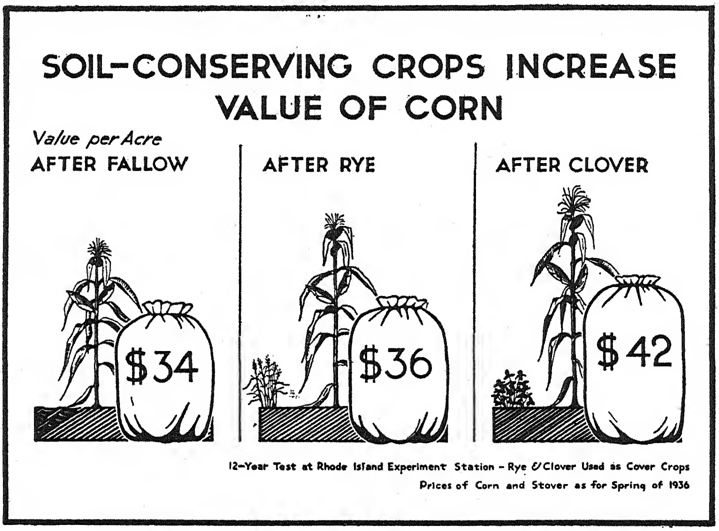
In parts of Kansas, Nebraska, and other dry, windy regions, corn is planted with the lister which opens small furrows to a depth of 5 or 6 inches, planting the kernels in rows 3 feet 6 inches apart at the bottom of the furrows.

In the Corn Belt and northern regions, corn is planted at depths varying from 1 to 2 inches. On well-worked loams, 2 inches is the best depth. On heavy soils or on poorly drained soils, planting at 1 inch will give better results.

Cultivate to Kill Weeds without Pruning Corn Roots. It is an excellent practice to harrow, immediately after planting, with the spike-tooth harrow or weeder, or to use the rotary hoe. On heavy land it is safe to use a spike-tooth harrow, with teeth set slanting backward, until the corn appears above the ground. The weeder may be employed until the corn is 6 to 8 inches in height. The rotary hoe, used at intervals of 3 to 5 days until corn is 12 to 16 inches high, controls weeds very effectively at the minimum cost. At least one cultivation to shallow depth is usually given after the rotary hoe is used until top growth prevents though, on clean ground, rotary hoe cultivation alone is given with good results.

The first cultivation with the corn cultivator where rotary hoe is not used may be made as soon as the corn is so high

that the rows can be easily followed. This cultivation should be about 3 inches deep, with small shovels, close to the rows. The second cultivation should come 5 to 8 days later and should not be quite so deep; blade attachments should be used. Throwing dirt to the plants when making early cultivations



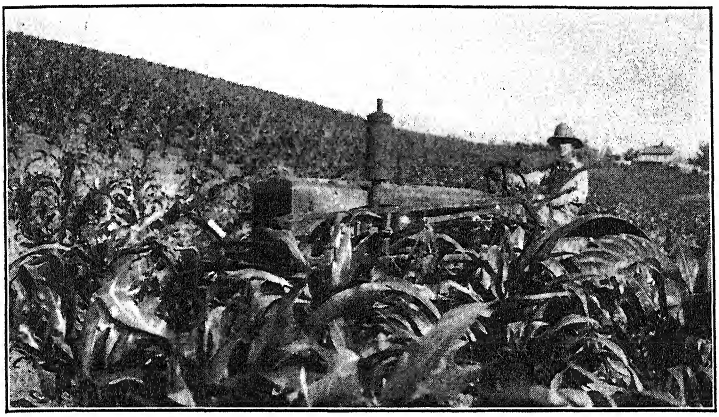
A.A.A., U.S.D.A.

Higher yields of corn result when corn is grown in rotation after clover.

covers and kills small weeds in the row. The subsequent cultivations should be made at intervals of 1 week to 10 days and should be shallow; blade attachments should be used and should not go to a depth of more than 2 inches. Care should be taken not to approach too near the corn plants, in later cultivations, to avoid injury through pruning feeding roots. It should be kept in mind that after a growth of 35 or 40 days, the roots of the corn plant interlace between the rows and, closely approaching the surface, fill the space between the hills with a dense network of fine feeding roots. Cultivating deeper

than 2 or 3 inches, or too close to the plant, at this time will cut these important feeding roots and cause a decrease in yield.

Two to four cultivations are usual, depending on the season and condition of the seed bed; fewer will be needed if the seed bed was prepared with the rotary hoe, harrow, or weeder. Additional cultivations generally give a slight increase in yield, but too many cultivations may cost more than the increase in



Courtesy L. D. Clements, Nebraska

This Nebraska Vocational Agriculture student cultivates his corn project with a tractor purchased from funds made by his project program.

yield will justify. The number of cultivations necessary will depend on the season and the condition of the land. It is imperative that cultivation be sufficiently frequent to control weed growth effectively. Land that has been thoroughly prepared before planting will require fewer cultivations than land not so well fitted.

Cultivators carrying numerous small shovels or blades, designed to accomplish thorough surface cultivation, have rapidly displaced the old type of corn cultivators carrying larger and fewer shovels.

Harvest when Properly Matured. Corn is ready for harvest when it is fully mature or when growth is checked by a heavy

TABLE 17

EXPERIMENTS SHOWING RESULTS OF VARIOUS METHODS OF TILLAGE FOR CORN

("Soil Moisture and Tillage for Corn," by Mosier and Gustafson, *Illinois Agricultural Experiment Station, Bul.* 181.)

Cultivation	Five-Year Average	
	Yield per acre, bushels	Average percentage of No. 2
1. None, scraped surface	68.3	97.6
2. Shallow, 4 or 5 times	70.3	100.0
3. Deep, 4 or 5 times	66.7	96.9
4. Shallow, 12 to 14 times	72.8	103.6
5. Deep, 12 to 14 times	64.5	91.7
6. Ordinary cultivation	75.8	109.5
7. Roots pruned, ordinary	64.2	90.2
8. Roots not pruned, weeds scraped off	80.7 (4 yr.)	106.4
9. Roots pruned with knife, weeds scraped	63.8 (4 yr.)	84.1

("Corn Culture," by Hutchison and Wolf, *Virginia Agricultural Experiment Station, Bul.* 214.)

Treatment	Four-Year Average Yield per Acre	
	Grain, bushels	Fodder, tons
No cultivation, weeds allowed to grow	8.17	0.71
No cultivation, weeds cut with hoe	49.04	1.41
3 cultivations	59.43	1.59
5 cultivations	58.68	1.56

frost. The ears are often husked from the standing stalks and thrown into a wagon driven along with the huskers; or the corn is cut and shocked and the ears husked later from the shock. Corn-harvesting machinery is widely utilized to reduce labor.

In northern states, 30 to 70 per cent of the crop is put into the silo. The best time to cut for ensilage is when the crop has practically matured but retains enough moisture to make succulent silage.

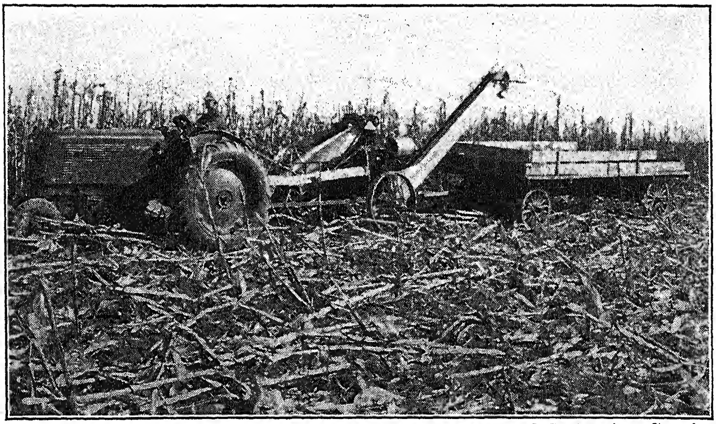
Store in Well-Ventilated Cribs. At time of harvest, corn usually carries from 20 to 35 per cent of moisture. To dry the corn properly and to prevent molding, the crop should be stored in well-ventilated cribs. A good storage crib is built with walls of properly spaced siding, sufficiently narrow to give good ventilation. The cribs should be made narrow, 4 to 6 feet at the bottom, and, if the corn is exceedingly high in moisture, partitions should be constructed, an air space of 6 inches or 1 foot to give ventilation through the center being left. Laying tile crosswise will also aid in ventilating.

The cribs should be covered with a good roof, and protection should be offered against the entry of mice and rats. Excellent sheet-metal cribs are now in general use.

Hog Off Corn to Fatten Hogs Cheaply. The hogging off or pasturing off of standing corn is a common practice in the Corn Belt. It has been proved by numerous experiments that this method of harvesting corn is economical in saving labor of harvesting and of feeding, and also from the standpoint of the gain in weight of the hogs being fattened. The manure produced is left directly on the ground, thus benefiting the land and preventing a waste of fertility. Corn may be pastured in the field with sheep in the same manner.

One man can handle a larger acreage of corn and feed out more hogs under this system than under any other. The hogs should not be allowed to cover too much ground at one time. A good practice is to fence off the part of the field to be hogged down, by use of a 3-foot woven wire fence, held by

anchor posts at either side of the field and supported by occasional posts or tied with binder twine to stalks of corn. Hogs should be turned in when corn is in the hard dough, or almost mature, stage. All or part of the field may be hogged down. From 2 to 8 acres should be fenced off at a time. When the area is cleaned up, fences should be moved to include an equal area of standing corn.



Pennsylvania State College, Agricultural Extension Service

The mechanical corn husker greatly reduces labor costs in harvesting corn.

Under average conditions, in corn yielding 40 bushels, or 80 baskets per acre, 4 to 6 hogs can be carried per acre. Heavier yields will carry more hogs. It will take 6 to 8 weeks for 4 to 6 hogs to clean up an acre of good corn.

It is advisable to plant rape, rye, or soybeans with corn which is to be hogged down. Rape should be planted at the rate of 2 pounds per acre of Dwarf Essex Rape at the last cultivation, and rye at the rate of 1 bushel per acre at the last cultivation. A mixture of the rape and rye is often more effective for late fall pasture than either seeded alone. Rye and vetch, at the rate of 1 bushel of rye and 20 pounds of hairy

vetch, is another excellent seeding to be made with corn at the last cultivation.

Drilling in 6 or 8 pounds of soybeans with the planter attachment or immediately after corn is planted furnishes additional forage for hogs.

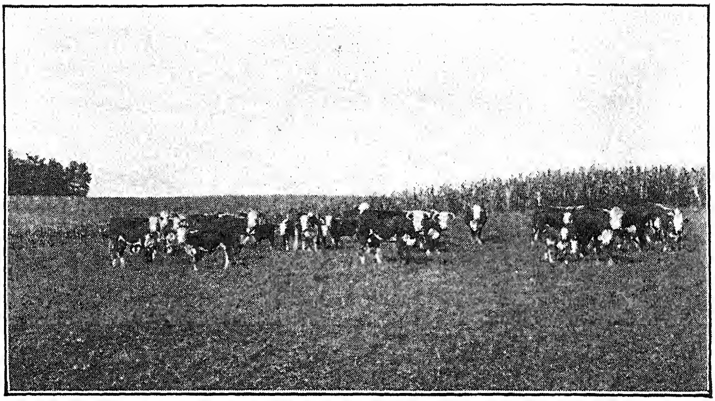
Rye or barley can be grown separately to furnish an early grain for hogging off.

Making Ensilage. Dairy and livestock sections are marked by the presence of numerous silos for the storage of corn and other crops used for ensilage purposes. By the use of the silo, the growing of corn has been made dependable and profitable in many regions far north of the Corn Belt. In sections where the rainfall is too great for the profitable making of hay, the silo may be used. More feed can be stored in a given space, with less loss, in the silo than in any other way; corn can be harvested and fed more cheaply if a silo is used. Moreover, ensilage is easily fed and highly palatable; it keeps up the milk flow of dairy cows, and it is excellent in feeding cattle and sheep. The crops generally used for ensilage are corn, sunflower, sorghum, peas and oats, soybeans, and sweet clover. Of these the principal crop is corn.

Choose the Best Hybrid Variety for Ensilage. It is a mistake to plant corn of exceedingly late-maturing varieties which fail to produce a well-developed ear. About one-third of the food value of corn is in the ear; hence the variety that produces the most in food value must produce a good ear. A hybrid variety, adapted to the locality, which produces highest grain yields or a somewhat later-maturing hybrid variety which reaches the dented and glazed stage of kernel maturity should be used. Methods of planting and cultivating are much the same for ensilage as for grain. The planting may be made at a slightly heavier rate and not too deep.

Harvest at Proper Stage of Maturity. The best time to harvest for ensilage is when the grain has become glazed and the lower leaves of the stalks have turned brown, but before the plant has become too dry to make good ensilage. Immature

corn makes poor ensilage, since it is much lower in food value than the mature crop. If corn is allowed to become too ripe and dry, the digestibility is lessened, and it is more difficult to make good ensilage without using a large amount of water. Frosted corn should be immediately put in the silo. Corn dries quickly when frosted; hence water should be used.



U.S.D.A. Extension Service

Corn and alfalfa, lespedeza, or clover furnish a balanced ration for the efficient feeding of livestock.

Corn is cut for the silo with a harvesting machine or by hand. The use of the combined corn harvester and loader greatly reduces the cost of handling. Silage corn is now often chopped in the field and blown into the silo. Corn should be hauled to the cutter on low-wheeled wagons or on low-swung racks.

Cut into Fine Pieces for Ensilage of Best Quality. When corn or another crop is being run through the ensilage cutter, care should be taken not to run it too fast, so that the pieces may be of small size. The cutter should be fed slowly and the pieces cut as near one-half inch in length as possible. The smaller pieces pack more tightly in the silo.

Pack Firmly in Tight Silo to Avoid Air Spaces. Ensilage material as it comes from the cutter is elevated to the top of the silo by a blower and falls in a stream into the silo. One or two men should be kept inside the silo to distribute the material uniformly and to tramp it tightly. If silage distributors are part of the equipment, one man can handle the job, since the material can be placed anywhere in the silo and will pack without tramping. Tight packing prevents firefanging and spoilage.

Add Water if Crop Is Dry or Frosted. If the corn becomes too dry in the field or is touched by frost, it is usually necessary to add water in the making of ensilage. The water may be added through the blower or it may be poured over the ensilage material as it is put in the silo. Enough should be used to dampen the material fully and to provide the right conditions for fermentation and keeping quality. It is easy to use too little, but it is very seldom that too much water is used.

The *pit or trench silo* is being used extensively, particularly in regions of moderate or deficient rainfall. A trench is dug with plow and scraper or scoop on a gentle slope where drainage is good. The trench should be 10 feet wide at the bottom, 8 feet deep, and 14 feet wide at top. The corn, sorghum, or other material must be ensiled, harvested, cut at the proper stage, and packed tightly in the trench, which is then covered with damp straw or green hay and carefully packed and weighted with earth or stones. Ensilage stored in a well-constructed pit silo was found by the Texas Experiment Station to be palatable and in good condition for feeding after 10 years. The economy and efficiency of the trench silo have greatly increased its use in storing feed reserves.

Some Points in Favor of Silage.[4] Within the last forty years silage has come into general use throughout the United States, especially in regions where the dairy industry has reached its greatest development. Silage is universally recognized as

[4] *Farmers' Bulletin* 556.

a good and cheap feed for farm stock, particularly for cattle and sheep. There are several reasons for the popularity of silage.

1. More feed can be stored in a given space in the form of silage than in the form of fodder or hay.
2. There is a smaller loss of food material when a crop is made into silage than when cured as fodder or hay.
3. Corn silage is more efficient feed than corn fodder.
4. An acre of corn can be placed in the silo at less cost than the cost of husking and shredding the same area.
5. Crops can be put in the silo during weather that could not be utilized in the making of hay or curing fodder.
6. More stock can be kept on a given area of land when silage is the basis of the ration.
7. There is less waste in the feeding of silage than of fodder. Good silage properly fed is all consumed.
8. Silage is very palatable.
9. Silage, like other succulent feeds, has a beneficial effect upon the digestive organs.
10. Silage is the cheapest and best form in which a succulent feed can be provided for winter use.

Time to Cut Corn for Ensiling. A study of Tables 18 and 19 will show why corn should be cut for the silo at the glazed and dented kernel stage and why immature corn is poor feed.

Sunflowers for Ensilage. The use of sunflowers for ensilage is a well-established practice in regions just north of the areas where corn gives satisfactory and dependable yields. In Montana, northern Minnesota, northern Michigan, and Ontario the sunflower is now quite commonly planted for ensilage.

Yields of 16 to 20 tons are common, and the Michigan substation, at Chatham in the Upper Peninsula, reports a yield of 26 tons per acre on 9 acres.

The mammoth Russian variety is the most widely planted. The ground is prepared as for corn, and the sunflower seed is planted in late May or June, in rows 36 inches apart, 8 to 12 pounds of seed per acre. Cultivation is carried on as for corn.

TABLE 18

CHEMICAL CHANGES DURING GROWTH OF CORN PLANT *

Yield per Acre	Stage of Growth				
	Tasseled July 30, pounds	Silked Aug. 9, pounds	Milk Aug. 21, pounds	Glazed Sept. 7, pounds	Ripe Sept. 23, pounds
Total yield	18,045	25,745	32,600	32,295	28,460
Water	16,426	22,666	27,957	25,093	20,542
Dry matter	1,619	3,078	4,643	7,202	7,918
Ash	138.91	201.30	232.15	302.48	364.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.92	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

* *U.S.D.A., Farmers' Bul.* 556.

TABLE 19

YIELD OF DIGESTIBLE MATTER IN CORN *

Constituent	Yield per Acre		
	Ears, pounds	Stover, pounds	Total crop, pounds
Protein	244	83	327
Carbohydrates	2301	1473	3774
Fat	125	22	147
Total	2670	1578	4248

* *U.S.D.A., Farmers' Bul.* 556.

The crop should be harvested for the silo when the seed is forming and before there is great loss of leaves.

Ordinary corn machinery is used, and the crop is put in the silo in a similar manner.

Sunflowers are sometimes mixed with corn for ensilage purposes, in the proportion of 6 pounds of corn to 6 pounds of sunflower seed per acre.

U.P. Exp. Sta., Michigan

Sunflowers for ensilage and root crops provide succulent winter feed in regions too far north for dependable corn crops.

Sunflower ensilage gives satisfactory feeding results; the Michigan Experiment Station reports sunflower silage to be 90 per cent as effective in maintaining the milk flow of dairy cows on test as high-grade corn silage.

Other Crops for Ensilage. Peas and oats make excellent ensilage in northern regions. One and one-half bushels of peas and 1½ bushels of oats per acre are drilled or broadcast in early spring. When the peas begin to fill, the crop is cut for the silo. A mower with peavine lifting attachment is used for this purpose.

The ensilage should be cut into pieces 1 or 2 inches long. A 6-ton yield is considered good.

Alfalfa, sweet clover, clover, and soybeans can be made into good ensilage, if they are packed tightly. Ensilage from alfalfa and soybeans putrifies rapidly during hot weather. Spraying 60 pounds of molasses per ton of green alfalfa, as it is put in the silo, preserves the ensilage and provides high-quality feed according to experiments at the Wisconsin Experiment Station.

These crops are not so desirable as corn; but the silo can be used during seasons that prevent hay making.

Mixing soybeans with corn for ensilage, in the proportion of 4 to 6 quarts of soybeans to 4 to 6 quarts of corn per acre, has become a common practice. Somewhat heavier yields are secured, and the soybeans add to the feeding value of the ensilage.

See Chapter XXIII, "Growing Soybeans and Cowpeas."

Rye and oats, when they are cut in the milk, can be put in the silo if firmly packed. Mixing with clover or alfalfa gives ensilage of better quality. The hollow stems of the grain plants carry air and induce spoilage.

Sorghum makes excellent ensilage and is considered next to corn in value for this purpose. See Chapter XXII, "Sorghum Growing."

Hay grasses cut green are now being used successfully for ensilage in eastern dairy regions.

Growing Popcorn. Popcorn has long been a fireside favorite on winter nights, but with the invention of the mechanical corn-popping machines, which are familiar sights in railway waiting rooms and wherever crowds pass by, the growing of popcorn has passed from the family garden stage, and popcorn has taken rank as a field crop of importance.

The old varieties of popcorn are being replaced by hybrids some of which increase yields more than 50 per cent. Attention has been given in breeding work to the production of popcorn varieties which have a greater volume when popped, are better flavored, and have greater tenderness. One of the profit-

able hybrid popcorns is Purdue No. 38 produced by the Indiana Experiment Station. Other valuable hybrids, such as the South American hybrids and the K_4 of the Kansas Experiment Station, are now available.

The ordinary methods of growing corn are used in general in popcorn growing. Great care should be expended in careful seed-bed preparation. The use of manure and 250 pounds of acid phosphate per acre increases yields, hastens the crop to maturity, and gives a more mature and hence better popping corn. Popcorn should be planted in rows 36 inches apart when the ground is well warmed; clean cultivation is necessary. It should be harvested when it is mature, and it must be dried thoroughly, either in crates or spread out thinly on the barn floor. Cribs with narrow partitions, with air spaces between, are used by large growers.

Growing Sweet Corn. The early Golden Bantam sweet corn has become a leading favorite for table use, although the Country Gentleman is still highly esteemed later in the season. Many prefer to plant Golden Bantam at two-week intervals until early July. Recently hybrid sweet corns developed from strains of Golden Bantam and other varieties have rapidly replaced common mass selection varieties for truck and canning crop use. The Purdue Hybrid Golden Cross Bantam, the Norcross of Minnesota, and the Seneca of New York are among the leading hybrid varieties of sweet corn.

The widespread home-garden program of World Wars I and II educated many to the superior qualities of the Golden Bantam, particularly the Golden Cross Bantam, and the strong market prejudice in favor of white sweet corn no longer prevails.

Sweet corn will repay extra expense in seed-bed preparation and fertilizing. A manured sod, fall-plowed, is an excellent foundation for a good crop.

When the seed bed is being fitted or the corn is being planted on manured ground, 200 or 300 pounds of acid phosphate should be used; 400 pounds or more of complete fertilizer, such

as a 4–12–6, should be used on less fertile ground. Sweet corn should be planted in rows 36 inches apart, kernels 8 to 10 inches apart. It should be harvested when the silk turns brown and kernels are in the milk.

General Information

Origin and History of Corn.[5] The corn crop is American in origin, and became known to white men when Columbus found the Indians growing *mahiz.*

It is probable that corn originated in Peru and spread to Mexico and northward. Gama grass and Teosinte, corn-like grasses of southern Mexico, may have entered into the ancestry of the corn plant.

When the colonists first settled in this country, they readily learned from the Indians how to plant, cultivate, and harvest the corn crop. Corn became the most important crop of the early settlers, and it is doubtful if the first attempts at colonization could have succeeded without it.

The Types or Groups of Corn Varieties. Most corn growers are familiar with the widely grown dent corn of the Corn Belt, with the shorter-seasoned flint corn, and with popcorn and sweet corn. The primitive pod corn and the flour corn of the Southwest and Mexico are less familiar types. These types vary greatly in adaptation and kernel characteristics, and, with the exception of pod corn, are used for various purposes.

Dent corn constitutes 90 per cent of our corn crop. It is characterized by hard-sided kernels which are dented at the top or crown because the softer center shrinks at maturity.

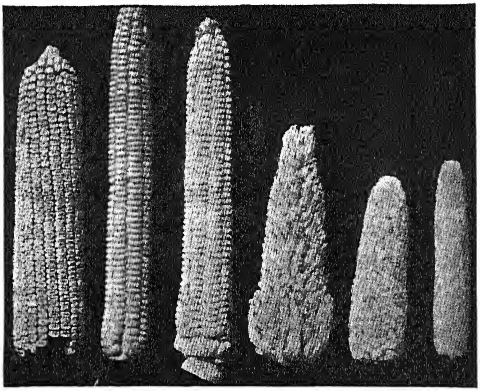
Flint corn has a hard, smoothly rounded crown and hard-sided kernel. The ears are longer and more slender, and it is

[5] For a complete account, read: *Corn and Corn Growing,* by H. A. Wallace and E. N. Bressman; "The Corn Crop," Separate No. 872, *Yearbook of the U. S. Department of Agriculture,* 1921; *Beginnings of Agriculture in America,* by Lyman Carrier.

grown chiefly in regions of short seasons. Corn meal made from flint corn is highly esteemed.

Popcorn is small kerneled and small eared. The kernels are hard and vitreous throughout. When heated, popcorn explodes into a fluffy mass.

Sweet corn is characterized by the high percentage of sugar in its endosperm or kernel material. The mature kernels are



The types of corn. From left to right: dent corn, flint corn, flour corn, pod corn, sweet corn, popcorn.

shriveled and translucent. It is used in the green state as a vegetable and for canning.

Pod corn has each kernel enveloped in a husk with a large husk covering the entire ear. It has little economic importance and may represent a primitive type of corn.

Flour corn, or soft corn, has soft, starchy kernels. It is grown by the Indians of our Southwest and Mexico. The kernels are easily ground into flour by primitive methods.

The flour-corn varieties are best adapted to planting under the hot, dry conditions of the Southwest.

Importance and Uses of Corn in the United States. Corn is the most important crop produced in the United States. Though unknown to the world before the discovery of America,

it rivals wheat as the most important cereal of the world. The welfare of a multitude of people is affected by the annual fluctuations in the success of the corn crop.

Corn furnishes the basis for our great livestock-feeding industries. A corn country is invariably a good hog and cattle country. Corn silage and corn feeds have made possible great dairy development.

For human consumption, corn has always been important in America. Corn bread, corn-meal mush, cornstarch puddings, sweet corn, and popcorn are familiar foods.

The manufacture of corn products has developed into an industry of immense magnitude. Cornstarch, glucose, and corn sugar are made from the starchy part of the kernel. The germ furnishes corn oil, which is used as a salad oil and for making paints and varnishes and synthetic rubber. The germ also furnishes a high-protein dairy feed. More uses are constantly being found for this valuable product.

Corn became our greatest war crop during World War II. Alcohol made chiefly from corn was used in the manufacture of synthetic rubber, explosives, plastics, and high-octane gas for aircraft.

Modern Corn-Breeding Methods. The latest and most promising method of corn breeding developed by plant breeders of the United States Department of Agriculture and at leading experiment stations consists of the self-pollination of a number of corn plants for a number of seasons; the resulting progeny is tested in an ear-row test, and the most desirable strains are recombined to secure high yield, proper adaptation, and other desirable qualities.

The first generation crosses of such strains of selected selfed plants frequently give remarkable results. Yields far in excess of the parent strains are obtained, but the yields fall below the first generation cross in the second and following generations. Only first generation crosses give high yields.

The desirable lines of parentage, two or four or more, must be increased separately in isolated fields and brought together,

after increase, in another isolated increase field. When rows planted to one selfed or pure-line strain, alternated or intermingled with one or more pure-line strains, are detasseled, crossing is assured. Seed from the detasseled row carries the high-yielding ability that is desired.

The crossings of the selected parents must be made annually from properly guarded increases of the selected selfed parent lines that are known to nick properly. Such intensified breeding work is now done by experiment station plant breeders and by the plant breeders of hybrid seed-corn companies in a number of states.

TABLE 20

COMPARATIVE ACRE YIELDS OF SHELLED CORN OF THE DOUBLE CROSS, BURR-LEAMING, AND OF FIVE HIGH-YIELDING VARIETIES AT MOUNT CARMEL, CONN., 1918–1922

From *U.S.D.A.*, *Bul.* 1489, "Corn Breeding," by F. D. Richey. (Data from Jones and Mangelsdorf, *Bul.* 43, p. 161.)

Designation of Variety	Acre Yields of Shelled Corn, Bushels					
	1918	1919	1920	1921	1922	Average
Burr-Leaming (double cross)	116	88	55	95	63	83.4
Beardsley's Leaming	96*	54	51	85	48	66.8
Luce's Favorite	....	79*	38	81	50	62.0
Webber	81	62	57*	73	49	64.4
Northern white	84	75	32	87*	....	69.5
Century	68	51	55	77	67*	63.6
Average of five varieties	82.3†	64.2	46.6	80.6	53.5†	65.4

* The highest yielding of the commercial varieties in each year is marked with an asterisk.

† Average of four varieties only.

Watch Out for the European Corn Borer, a Menace to the Corn Crop. The European corn borer is one of the most undesirable aliens that has ever come to this country. It is a first-class destroyer of corn, sorghum, broom corn, and a number of other plants having fleshy roots or stalks, such as celery, bean, sunflower, and rhubarb. Worst of all, it will feed when forced to do so on a long list of less important crops and on many weeds, notably the smart weeds (*Polygonum*). The insect was first noticed in this country in 1917, when it appeared in the vicinity of Boston; since then it has appeared in New York State, Pennsylvania, Ohio, Indiana, and Michigan, as well as in Ontario, Canada. The insect is so well established at this time that we must forego all hope of ever exterminating it.

In corn the larvae tunnel through the stalks and the ears, and even bore into roots, tassels, and leaf ribs. The presence of the pest is often revealed by the breaking over of the tassel, which has been weakened by the tunneling of larvae. Other larvae bore into the growing ears, and all parts of grain and cob are utilized for food.

Similarly, other plants are pierced by tunnels, and such plants serve as distributors of individuals to new localities when they are carried from place to place. The carrying of cut flowers, such as dahlia, chrysanthemum, and gladiolus, or of plants such as chard, beans, celery, beets, spinach, from an infested district to one in which the pest is not already established is to be discouraged. The injury to corn may vary from a slight one to a total loss.

The corn borer passes the winter as a full-grown larva or worm about an inch long in a tunnel burrowed in the plant on which it is working. Here it rests until about the middle or last of May, when an exit hole is prepared; a flimsy cocoon is spun in which the change to a pupa takes place. During June the adult moth, capable of flying a distance of many miles, emerges from the cocoon. Eggs are placed in groups of 15 or 20 on the leaves or the stems of plants; some females

produce over 1000 eggs each. From these eggs come the larvae which do all the damage. Sometimes one generation and a partial second is produced in a season, at other times two generations.

The spread of the corn borer seems to be considerably arrested by the practice of low cutting. Corn cut low and placed

U.S.D.A.

Turning under cornstalks in Michigan to control the corn borer.

in the silo supplies the minimum of stubble for the larvae during the winter.

The principal measure which promises control of this pest is the destruction of remnants of corn plants, sorghum, broom corn, and weeds, the most important of which is smart weed. Cornstalks not used by the first of June should be disposed of; refuse from canning factories and broom factories, and garbage containing any fleshy stems or parts of plants should be destroyed. The fall plowing of stubble in infested fields and the rolling of such stubble fields previous to plowing are helpful,

because they make it possible to bury plant parts more evenly and deeply.

For a comprehensive discussion of the pest, see *Farmers' Bulletin* 1294, U. S. Department of Agriculture, by D. J. Caffrey and L. H. Worthley, both of the U. S. Bureau of Entomology. Recent experiments at the Iowa and Illinois experiment stations have shown that dusting the corn plant in July and early August with 3 per cent DDT dust is effective in the reduction of corn borer damage.

Control Corn Smut by Rotation.[6] Corn smut is a fungus disease related to, but entirely distinct from, the smut diseases of other crop plants, such as wheat, oats, and barley. The smut affects the corn at almost any growing part, the stem, the leaf, the ear, the husk, the silk, or the tassel, and produces a swelling which is at first white and then becomes greenish black. The attack of corn smut may come at any time of the season when corn is growing, the newly formed tender parts being most subject to it.

Typically, the corn-smut fungus lives during the winter in the old stalks in the field. These live infectious spores are blown in the spring by the wind to young corn. A close examination of corn about a foot high will reveal a plant here and there with whitish overgrowths, the so-called smut boils. Only a few of these are formed, but they mature their spores and furnish the source of later infections. Over and over again the process is repeated until the corn shows in the fall a liberal amount of this wasting disease.

The control measures for corn smut depend on the nature of the smut's life history. Since infection takes place throughout the season, this disease cannot be prevented, as is oat smut or wheat stinking smut, by seed treatment. In short, any recommendation to dip seed for control of corn smut is unwarranted.

Since the source of smut in early summer is largely the old

[6] Dr. G. H. Coons, Michigan Experiment Station.

smutted stalks of last year's crop, the planting of corn to follow corn augments most seriously the amount of smut infection.

With a crop grown intensively, such as sweet corn or special lots of seed corn, rogueing of smutted plants early in the season is advisable. This practice and rotation will prevent loss. With corn as a field crop, the pulling and the destroying by fire of any smutted or deformed plants seen during cultivation are advisable. Further eradication of early infections by field inspection may not be practical. In any event corn must be harvested early in the season before the smut growth gets powdery.

Farmers, therefore, must not rely on seed treatment for corn. Instead they must consider rotation of crops their best ally in the battle with a wasting plant disease. The hope of the future lies in the securing of smut-resistant hybrids.

SUGGESTIONS

1. One of the outstanding developments in corn growing is the use of hybrid strains of seed. Secure from the state agriculture college or experiment station the available information concerning the locally adapted strains of hybrid corn. Make plans to test the value of hybrid strains on home farms.

2. Visit the experiment station or agricultural college and have the men engaged in corn-breeding work explain the methods of obtaining strains of hybrid corn.

3. Make detailed plans for the improvement of corn production on home farms. Analyze the whole procedure and decide on improvements which may be made.

4. Investigate the possibilities of producing hybrid corn for seed purposes. Such plans may be carried out in cooperation with the state seed-improvement association or some such agency working in close cooperation with the state college of agriculture.

5. Arrange for trips to fields in which hybrid corn is growing side by side with open-pollinated varieties. Under such conditions it is possible to compare the characteristics of the two types of corn. Often many differences may be readily observed.

6. Study the monthly prices of corn over a period of years in order to learn the seasonal price trends and also the effect of corn supplies

upon prices. Examine the relationship between the price of hogs and the price of corn.

7. Study the use of corn as a feed for various types of livestock to learn what protein concentrates must be used with corn to provide balanced rations.

8. Make a study of the market grades of corn.

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CHAPTER XX

WHEAT AND RYE GROWING

Wheat is the great bread grain of the world.

Wheat is the chief source of the world's bread supply. The large consumption of wheat in the United States assures the nation that the wheat crop will always be a leading crop in regions to which it is adapted. The United States and Canada have in the past ranked as leading exporters and can produce a very large excess above American needs. Although foreign demand was once the primary factor in determining the price received for American-grown wheat, the wheat crop as a whole is produced mainly for American consumption. During World War II, American wheat production was increased to provide our allies with needed supplies, and during the first years of peace American wheat acreage was expanded to record proportions to aid in preventing starvation on a world-wide scale.

The growers who make the most out of wheat, year in and year out, are those who produce the best quality for the market at the lowest cost per bushel. The following practices characterize the methods of the best wheat growers:

1. Choose the highest-yielding variety of best market quality.
2. Prepare a firm, finely surfaced seed bed.
3. Fan seed wheat thoroughly and treat to prevent smuts.
4. Plant wheat at the right time and depth.
5. Use fertilizers that pay a profit.
6. Harvest when chaff and straw are yellow and the seed is in tough-dough stage.
7. Grow wheat in a well-planned rotation.
8. Cooperate in adjusting acreage to market demands.

Choose the Highest-Yielding Variety of Best Market Quality. Wheat varieties differ greatly in adaptation and yielding ability. The right type of wheat must be grown in each wheat-growing region, and of this type the highest-yielding strain or variety should be adopted. Improved high-yielding varieties, developed chiefly by experiment station plant breeders, are available in practically all wheat states. These varieties have a marked advantage over ordinary, unimproved varieties, although the latter are still commonly grown by a great number of wheat growers. Examples of improved wheat varieties are the Kanred of Kansas, Pawnee of Nebraska, Minturki of Minnesota, Fulhio of Ohio, Iobred of Iowa (all winter wheats); and the Thatcher and Marquis, leading spring wheat varieties in Minnesota, the Dakotas, Nebraska, and Iowa.

Prepare Firm, Finely Surfaced Seed Bed. Wheat does best when planted on a firm, well-worked seed bed carrying sufficient moisture for rapid germination. Early preparation and thorough cultivation will put land in such condition. If winter wheat follows oats or barley, the stubble ground should be plowed as soon as possible after they are harvested. Disking as soon as oats or barley are harvested will prevent the loss of much moisture, and a better job of plowing can be done. For wheat the plowing is at an ordinary depth, 5 or 6 inches. Then the cultipacker or roller is used to pack furrow slice; the land must be disked or harrowed frequently. In regions where winter wheat follows corn, beans, or other cultivated crop, a thorough disking as soon as the crop is harvested will prepare a satisfactory seed bed. Spring wheat does best on fall-plowed land, or land plowed and fitted as early as possible in the spring.

Four to six weeks or more are usually required to put land in the best condition to receive the winter wheat crop, if plowing is necessary. If less time is offered, more attention should be paid to compacting firmly with the cultipacker or

TABLE 21

EFFECT ON YIELD OF WHEAT OF DIFFERENT METHODS OF PREPARING THE GROUND, MANHATTAN, KANSAS

(From *Bulletin* 248, "Wheat Production in Kansas," by S. C. Salmon and R. I. Throckmorton.)

Method of Preparing the Ground	Yield per Acre, Average for 10 Years, 1911 to 1920, Bushels
Double disked at seeding time; no other treatment	7.8
Plowed September 15; 3 inches deep	12.3
Double disked July 15; plowed September 15, 7 inches deep	17.4
Double disked July 15; plowed August 15, 7 inches deep	17.8
Listed July 15; ridges worked down	18.0
Listed July 15; ridges split August 15	18.3
Plowed July 15; 7 inches deep	20.7
Plowed August 15; 7 inches deep	19.1
Plowed August 15, 7 inches deep; not worked until September 15	16.8
Plowed September 15; 7 inches deep	11.7
Plowed July 15; 3 inches deep	15.0

roller, and the frequency of disking or harrowing should be increased.

Fan Seed Wheat Thoroughly and Treat to Prevent Smut. Seed wheat should be thoroughly fanned in a good fanning mill to remove weed seeds, smut balls, cracked kernels, shriveled kernels, dirt, and so forth. Weed seeds such as chess, cockle, and kinghead can be almost entirely removed by a thorough fanning. Seed wheat containing garlic, wild onion, or other weed seed which cannot be easily removed should not be planted. If kernels affected with bunt and stinking smut are removed, a much more effective treatment with formaldehyde can be given.

Stinking smut or bunt is controlled by treating with copper carbonate, formaldehyde, or ceresan. (Note Chapter XV.)

The hot-water treatment is used where loose smut causes serious loss. (Treatment given in Chapter XV.)

Plant Wheat at the Right Time and Depth. Winter wheat should be planted late enough to avoid the Hessian fly and early enough to develop a good top growth. The planting date varies with the locality. In central Indiana and Illinois it should be planted from September 25 to October 5; in central Michigan, from September 15 to 20. If the planting is done at the right time, Hessian fly damage can be effectively controlled. Early plantings are much more likely to be affected by the fly than late plantings. When farmers continue, over a period of years, to plant wheat too early, serious fly damage may result. Such a condition can be controlled by planting at fly-free dates.

Spring wheat should be planted as early as possible in the spring. Earlier plantings, as a rule, make a better start and have a longer period for favorable growth before the unfavorable weather of mid- and late summer. As a rule, 6 pecks to 2 bushels of winter wheat are planted per acre in the Corn Belt and Northern and Eastern States. In the Northwest 2 to 4 pecks are sufficient; the lighter rate may be used for early plantings when the seed bed carries sufficient moisture. If winter wheat is planted at a late date, so that tillering is retarded, 9 or 10 pecks will give better results. Spring wheat should be planted at the rate of 6 or 7 pecks per acre. Wheat should be planted at a depth of 1 to 2 inches. Care should be taken not to allow the drill to run too deep. Drilling gives better yields than broadcasting.

The rate of planting winter wheat necessarily varies with the date and with moisture and tilth conditions of the seed bed. Generally speaking, the earlier the seeding the lighter should be the rate. Table 22 gives the averages of yields from six rates during four years.

Use Fertilizers that Pay a Profit. In the preparation of wheat land, an application of manure at the rate of 4 or 6 tons

TABLE 22

AVERAGE OF ALL DATES AND DEPTHS OF SEEDING BY RATES

(*Idaho Bulletin* 145)

Year	Rate of Seeding in Pounds *					
	25	35	50	60	65	70
	Yield in Bushels per Acre					
1921	26.7	29.4	30.0	30.3	30.3	30.0
1922	18.3	22.0	25.1	25.6	24.4	24.1
1923	25.5	29.3	36.3	33.3	34.3	34.4
1924	13.9	15.5	14.9	15.4	15.4	15.3
Average	21.1	24.0	26.5	26.5	26.1	25.9

* Seed was treated with formaldehyde on nights before plantings were made.

per acre will greatly benefit the crop, for not only is plant food supplied, but also the water-holding capacity of the soil is greatly increased. It is unwise, however, to manure land which is high in organic matter before planting wheat. Manure or straw, used as a light top dressing in the fall or early winter, is very effective in preventing winter killing and in giving wheat a good start in the spring. Clover, seeded with wheat, is also benefited.

Manure is deficient in phosphorus, and the benefits secured from manure will be greatly increased if it is reinforced with acid phosphate or rock phosphate. Phosphate is the most effective mineral that can be applied to wheat in most wheat-growing regions. The average wheat soil of the Corn Belt and Northern States is deficient in phosphorus, and wheat draws heavily on this element in developing good grain yields. The

application of phosphatic fertilizer hastens maturity and increases yield. The usual application is 200 to 300 pounds of acid phosphate, applied at the time of seeding wheat, or, if phosphorus is applied in the form of rock phosphate or floats, 800 to 1500 pounds per acre should be used once every four years.

Commercial fertilizers are effective on soils of less than average fertility. On such land, 250 to 300 pounds of a complete fertilizer, such as a 4–12–4, may be used to good advantage.

Harvest Wheat when the Chaff and Straw Are Yellow and the Seed Is in the Tough-Dough Stage. It is of great importance that wheat be harvested at the right time, in order to secure wheat of the best milling quality and to prevent loss from overripeness. Wheat is ready to harvest when the kernel is in the hard-dough stage and the chaff and straw take on a yellow or golden color. At this time the kernel may be easily dented by the finger nail, but resists crushing in the fingers.

Under the conditions of the Northern Corn Belt and Eastern regions, wheat is generally harvested by cutting at this stage with the binder and stacking the sheaves in well-capped shocks. When the season is favorable and threshing service is certain, the crop may be threshed from the field. Many careful farmers, particularly seed-wheat growers, find it profitable to cure in the field for several days, stack in the mow or stack, and thresh after several weeks or more from the mow or stack.

The following practices aid in the maintenance of fertility: straw is used for bedding and is returned to the land as manure; straw is allowed to remain on the ground (for example, when a combine is used); straw is used as top dressing. The burning of straw or stubble leads to soil depletion.

Large combines have been generally used in the West and Northwest for many years, but recently small combines have become common where large acreages of small grains are grown on farms in the Corn Belt, the lower part of the North-

TABLE 23

THE EFFECT OF APPLICATIONS OF STRAW AND OF BURNING STUBBLE ON YIELD OF WHEAT, MANHATTAN, KANSAS

(From *Kansas Bulletin* 248)

	Average Yield per Acre			
	No straw applied		Straw applied	
	Stubble not burned bushels	Stubble burned, bushels	Before plowing, bushels	After plowing, bushels
Plowed deep in July	27.6	25.2	28.8	28.8
Plowed shallow in July	27.2	26.0	28.0	25.7

ern States, and as far east as Pennsylvania. When a combine is used, wheat is allowed to reach full maturity. The combine deposits the straw on the land, and straw needed for bedding must be raked and hauled to the mow or stack.

Grow Wheat in a Well-Planned Rotation. For continued profitable production it is essential that the wheat crop be grown in a well-planned rotation.

In regions where clover, alfalfa, sweet clover, and timothy thrive, seedings of these crops are effective if they are planted as companion crops, either in the spring on winter wheat, or seeding at the time of planting spring wheat.

In the Corn Belt the following rotations are usual:

A. (1st year) corn, (2nd year) oats, (3rd year) wheat, (4th year) clover.

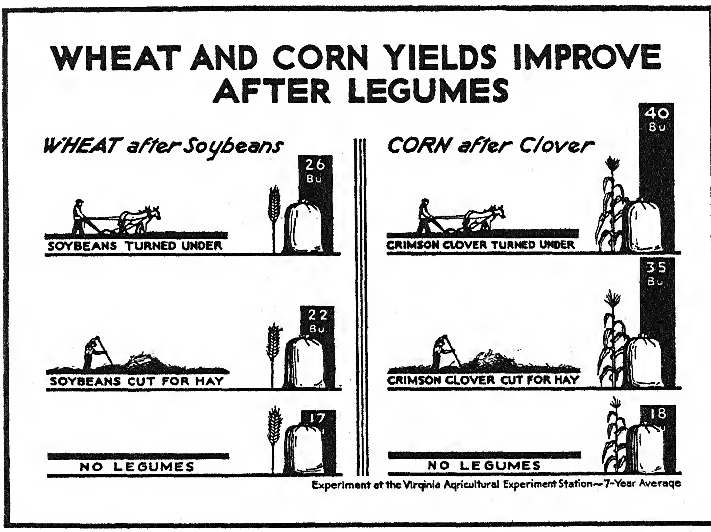
B. (1st year) corn, (2nd year) oats, (3rd year) wheat, (4th year) clover and timothy, (5th year) timothy.

C. (1st year) corn, (2nd year) wheat, (3rd year) clover or sweet clover.

D. (1st year) corn, (2nd year) wheat, (3rd year) clover and timothy, (4th year) timothy.
E. (1st year) corn, (2nd year) wheat, (3rd, 4th, and 5th years) alfalfa.

In the Northern States and the northern part of the Corn Belt, where corn is harvested too late to allow for the proper fitting of the ground for planting winter wheat, oats or barley or spring wheat usually follow corn in the following rotations:

A. (1st year) corn, (2nd year) oats, barley, or spring wheat, (3rd year) wheat, (4th year) clover or sweet clover.
B. (1st year) corn, (2nd year) oats, barley, or spring wheat, (3rd year) alfalfa, (4th year) alfalfa, (5th year) alfalfa.
C. (1st year) corn, (2nd year) oats, barley, or spring wheat, (3rd year) clover or sweet clover, (4th year) beans, (5th year) wheat, (6th year) clover or sweet clover.



A.A.A.

Wheat must be grown in rotation to maintain yield, control insects, and reduce losses from disease. The legumes charge soil with organic matter and increase yields of succeeding crops of wheat and corn.

Wheat gives greatest yields in rotations including alfalfa, sweet clover, or clover as compared to rotations including timothy. (Note Chapter XI, "Growing Crops in Rotation.")

Table 24 gives a comparison of yields of wheat in various rotations and grown continuously. Note the high yields secured in the alfalfa rotation.

TABLE 24 *

EFFECT OF ROTATION ON THE YIELD OF WHEAT AT THE AGRICULTURAL EXPERIMENT STATION, MANHATTAN, KANSAS

Preparation of the Ground	Yield in Bushels per Acre Average, 1913 to 1923		
	Grown in rotation with corn and oats	Grown without rotation	Difference in favor of rotation
Plowed July 15, 3 inches deep	26.8	15.0	11.8
Plowed July 15, 7 inches deep	26.7	19.0	7.7
Plowed August 15, 7 inches deep	23.2	17.0	6.2
Plowed September 15, 3 inches deep	17.0	11.4	5.6

EFFECT OF ROTATION ON THE YIELD OF WHEAT IN EASTERN KANSAS

Rotation	Average Yield per Acre for 17 Years, Bushels
Sixteen-year rotation: alfalfa, corn, and wheat	19.5
Three-year rotation: corn, cowpeas, and wheat	17.0
Wheat every year	14.9

* From *Bulletin* 248, Kansas Experiment Station.

Additional Information

Origin and History of Wheat. The origin of wheat and its use by man antedates our earliest recorded history. A primitive type of wheat is found in the remains of the Lake Dwellers of Switzerland, who cultivated it in the Stone Age. Wheat, very similar to varieties grown today, has been removed from the most ancient tombs of the Egyptians. The chief historical development of wheat is the increase in the use of the most desirable types and the development by all civilized peoples of varieties of superior yield and quality for various uses and adaptations.

Importance of Wheat. Wheat is the leading bread grain of civilized peoples. A wheat famine is the greatest food calamity that can befall a people. Under normal conditions, Russia leads in wheat production, with the United States second, and India, France, the territory formerly included in Austria-Hungary, Italy, and Canada in the order given.

The *groups of the wheat* family cultivated for human use are: common wheat, club wheat, poulard wheat, Durum wheat, emmer, spelt, Polish wheat, and Einkorn.

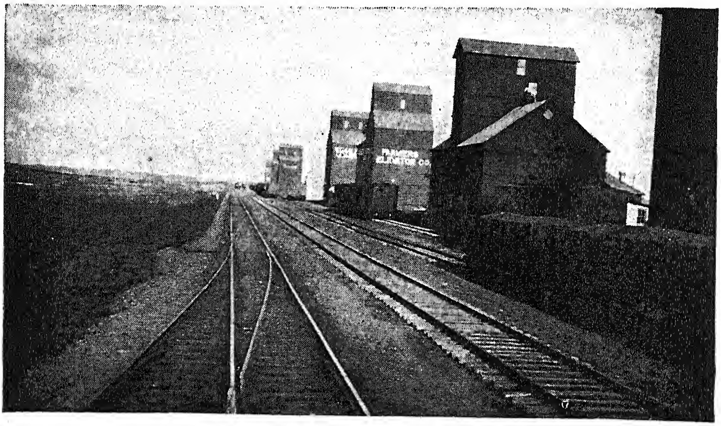
Einkorn or one-kernel wheat is the most primitive type. It is grown to a limited extent in the mountainous regions of Switzerland and is used chiefly for feeding livestock. The wheat found in the Swiss Lake Dwellings, which belong to the Stone Age, resembles Einkorn.

Spelt is an ancient type of wheat which was of great importance as a food grain in the time of the Roman Empire. It is grown today in Eastern Europe for human and animal food, and, to a slight extent, in this country. Spelt is very hardy and will thrive under severe conditions of drought. The kernels are retained in the chaff after threshing.

Emmer resembles spelt, but the heads are more compact. It is extensively grown in Russia for human consumption and for livestock feeding. White emmer, erroneously called speltz, quite frequently grown in the United States for livestock and

poultry feeding, gives fairly good results under adverse soil conditions, such as poorly prepared seed beds, wet soils, and droughty soils. The grain remains in the chaff when threshed.

Poulard wheat has unusually large club heads. It is grown in the hot, dry regions bordering the Mediterranean Sea and the Black Sea. This wheat is a macaroni wheat and is not grown in the United States.



Country elevators in North Dakota. Farmers deliver wheat to these elevators for shipment to terminal elevators at Minneapolis, Duluth, Superior, and other major wheat-marketing centers.

Polish wheat is grown in the Black Sea region. It has unusually long, hard, clear amber kernels and is used for making macaroni. This wheat is little grown in the United States.

Durum, a macaroni wheat, has exceedingly hard, amber-like kernels which are very high in gluten. This wheat is used chiefly in making macaroni. It is important in Mediterranean and South Russian wheat-growing regions and during the past sixty years has assumed so much importance in the United States that it occupies 5 to 7 per cent of our wheat acreage. Durum wheat is particularly adapted to regions that have too little rainfall for successful production of the common wheats.

Club wheats are grown so extensively in our Pacific Northwest that they occupy 5 to 7 per cent of our wheat acreage. They are classed as soft wheats and are used in making bread flour when blended with harder wheat. They make excellent pastry flour.

Common wheat, the chief bread wheat, is the most widely grown and used. About six-sevenths of our wheat acreage is planted with common wheat. The kernels are easily threshed from the chaff. They range in color from white to red. The flour made from common wheat, when it is moistened, forms a sticky glutinous mass. When yeast or baking powder is added, the carbon dioxide gas released is enmeshed, and the dough rises and, when properly baked, forms a light bread.

Soft wheats, low in gluten, produce a weak flour particularly adapted to pastry purposes.

Hard, or high-gluten, wheats produce a strong flour used in making bread of the best quality. Patent flours are made from hard wheats or blends including hard wheats.

Both spring and winter classes of common wheat are largely grown, according to their adaptation.

Wheat Classes. The leading wheat classes and market grades and their regional distribution for the United States, as given by the Bureau of Markets of the United States Department of Agriculture, are herewith presented:

The hard red spring wheats. The commercial class of wheat known as hard red spring, in which are included all the varieties of hard red spring common wheat, is grown principally in the north central part of the United States, where the winters are too severe for winter wheat to be grown safely. The states of North Dakota, Minnesota, South Dakota, and Montana lead in its production.

The hard red winter wheats. The commercial class of wheat known as hard red winter, which includes all the varieties of hard red winter common wheats, is grown principally in the central Great Plains area, where hot summers and rather severe dry winters prevail. The states of Kansas, Nebraska, and Oklahoma lead in its production. More than 18,000,000 acres of this class of wheat are grown an-

nually in the United States and comprise nearly one-third of the total wheat acreage. (*U.S.D.A. Bulletin* 1183.)

The white wheats. The commercial class of wheat known as white includes the common white wheats and the white clubs. Varieties of common white wheat are grown both in the eastern and western part of the United States. It is the leading class of wheat in Wash-

Michigan Exp. Sta.

Rosen rye in center, common rye at right, a cross of Rosen and common at left. Rosen rye is much superior in yield and quality but cross-pollinates readily.

ington, California, Oregon, and Idaho, and is important in New York and Michigan. In these states it usually outyields the other classes of wheat. Over 3,000,000 acres of common white wheat are grown annually in the United States. It comprises somewhat more than 5 per cent of the total wheat acreage. More than 50 varieties of common white wheat are grown. (*U.S.D.A. Bulletin* 1183.)

Rye Growing. The Northern States and Canada are best adapted to the growing of rye for grain purposes. In the Corn Belt and the Southern States, it is widely used as a cover crop, as a pasture crop, and for green-manuring. Rye is somewhat hardier than winter wheat and can be planted later in the fall

with assurance of a good crop. It also gives better results than wheat on soils of less than average fertility. Winter rye is more largely grown, since spring rye yields much less by comparison. The rye crop, however, responds to proper cultural methods and gives the best yields on soils in good condition. The following practices give best results with rye:

1. Grow the highest-yielding variety.
2. Clean seed with fanning mill and test germination of seed.
3. Plant sufficiently early on a well-prepared seed bed.
4. Use fertilizers where profitable.
5. Harvest when properly mature, cure, and thresh.

Grow the Highest-Yielding Variety. Rye is naturally an open-fertile, wind-pollinated plant; hence commonly grown varieties show greater variation and more numerous mixtures than the common varieties of other small grains, which are close-pollinated. During recent years, marked improvements have been made by plant breeders, in the leading rye-growing states, in the yielding ability and adaptation of rye varieties. In Michigan, the Rosen rye is an outstanding example of a great improvement in rye growing, because a superior variety has been developed and widely distributed. It was developed by the late plant breeder F. A. Spragg, from a small sample received in 1908 through Mr. J. A. Rosen, a Russian student, who secured the sample from his home farm near Riga, Russia. This sample was tested and compared with other ryes at the Michigan Experiment Station and found to show great superiority. In 1912 a bushel of Rosen from the college increase plats was placed in the hands of a Jackson County farmer, a member of the Michigan Crop Improvement Association, who planted it on an acre of ground away from other rye. The acre yielded 45 bushels and gave the first substantial start to the distribution of this rye. The Rosen outyielded common ryes 10 to 15 bushels per acre in many instances in Michigan. It rapidly increased in acreage. Large supplies of pure seed were made available through the activities of the

Michigan Crop Improvement Association. At present the Rosen or the near-Rosen occupies practically all the Michigan rye acreage, and this variety has become important in the rye-growing states of the northern Corn Belt, in New York, and on the lighter soils of southern Wisconsin and Minnesota.

In Wisconsin, the Wisconsin pedigree rye is recognized as the leading variety. This is a development of the plant-breeding work of the Wisconsin Experiment Station. In Virginia, Tennessee, and the Cotton Belt Abruzzi rye is generally grown. The Balbo rye developed at the Tennessee Experiment Station and the Abruzzi rye are considered best for pasture and cover purposes in the lower Corn Belt and Southern States.

Clean Seed with Fanning Mill and Test Germination. Seed rye should be thoroughly cleaned with a good fanning mill before it is planted. If ergot is present, other seed should be secured. Although rye seed that has been properly stored usually germinates well, it is good practice to test the germination of seed before planting so that the planting rate may be regulated or other seed obtained if necessary.

Plant Sufficiently Early on a Well-Prepared Seed Bed. Rye can be planted safely one or two weeks or more after the usual planting date for wheat. Higher yields and better results can be secured, as a general rule, if rye is planted about the same time, or only a few days later, than wheat. Late fall planting will result in decreased yields. Rye should be planted at the rate of 1 bushel to 6 pecks for Rosen, and 6 pecks to 2 bushels for most other varieties, per acre. Drilling gives higher yields than broadcasting. Rye should be planted at a depth of 1 or 2 inches, 1 inch on heavier soils and 2 inches on soils light in texture.

Use Fertilizers where Profitable. Fertilizers are not so generally used on rye as on other grain crops. Nevertheless, rye responds remarkably well to the proper use of commercial fertilizers and manure. The use of 200 to 300 pounds of acid phosphate per acre will markedly increase the yield of rye and

improve its quality. Manure, applied during the preparation of the seed bed or in the fall or early winter, increases rye yields to a considerable extent, particularly on light soils.

Harvest when Properly Mature, Cure, and Thresh. Rye should be harvested as soon as possible after it matures. If it is allowed to become overripe, large losses due to lodging and to the shattering of kernels may occur. Rye is usually cured in the field in open shocks.

Rye straw often brings a good price on eastern markets. If the straw is to be sold for the manufacture of mats, bundle cases, and so forth, care should be taken in handling the crop to prevent the breaking of straw, and the crop should be threshed by a separator equipped with a belt straw conveyor, rather than by the blower type of straw harvester and stacker.

As soon as it is threshed, the rye should be stored in properly constructed, well-ventilated bins, or sold immediately. If damp when threshed, it should be laid out on a barn floor and stirred until dry.

General Information

Origin and History of Rye. The earliest historical record concerning rye is its use by the Romans in the first century B.C. It was grown at an early date in the regions which now constitute Spain, where it shows a tendency to perennial growth.

Importance and Uses. During the war period the acreage of rye increased greatly, owing to foreign demand. Under ordinary conditions it occupies the fifth place in importance as a grain crop in northern states. In the South it ranks as one of the most important green-manuring crops. Rye is used chiefly in the making of rye flour and as a feed for livestock. It is used also for making hay, for pasturing, and for green-manuring. The straw is used in the packing of nursery trees, in the manufacture of mats and bottle protectors, and in the packing of horse collars.

The Ergot of Rye. Ergot frequently causes large losses of rye. This fungus disease causes the formation of large, purplish-black finger-like bodies which replace the kernels. Ergot-carrying rye is poisonous to human beings and livestock and may cause abortion in pregnant animals.

Only ergot-free seed should be planted. However, seed carrying ergot bodies may be planted if it is more than one year old, since the ergot bodies lose their vitality after this period. To remove ergot bodies the rye is poured into a 20 per cent solution of common salt and water and stirred; then the ergot bodies may be skimmed off. Salt and water are added until the rye kernels sink and the ergot bodies float.

SUGGESTIONS

1. Secure from your state agricultural experiment station the facts about the yield and other qualities of various varieties and strains of wheat and rye. Determine the improved varieties best suited for local conditions.

2. If wheat or rye growing is important on home farms, analyze these enterprises in detail for profitable ways to improve the yield and quality.

3. Secure samples of various market classes and grades of wheat and rye. Study the samples carefully and become familiar with the market standards.

4. Investigate the possibilities of growing wheat or rye for seed purposes. More than premium prices may be obtained if grains of seed quality are raised.

5. If wheat and rye growing is important on home farms, it is suggested that trips be made to an experiment station to see the experimental plots of these grains.

6. Study the weekly or monthly prices for wheat and rye over a period of years. In the case of wheat it is especially interesting to compare local, Chicago, and Liverpool prices. How can the differences be accounted for?

7. Visit elevators to learn how grains such as wheat and rye are stored. Study the procedures followed in marketing such grain.

8. Arrange to visit a mill that makes wheat or rye flour. The manufacturing processes are very interesting.

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CHAPTER XXI

OATS, BARLEY, BUCKWHEAT, AND FLAX GROWING

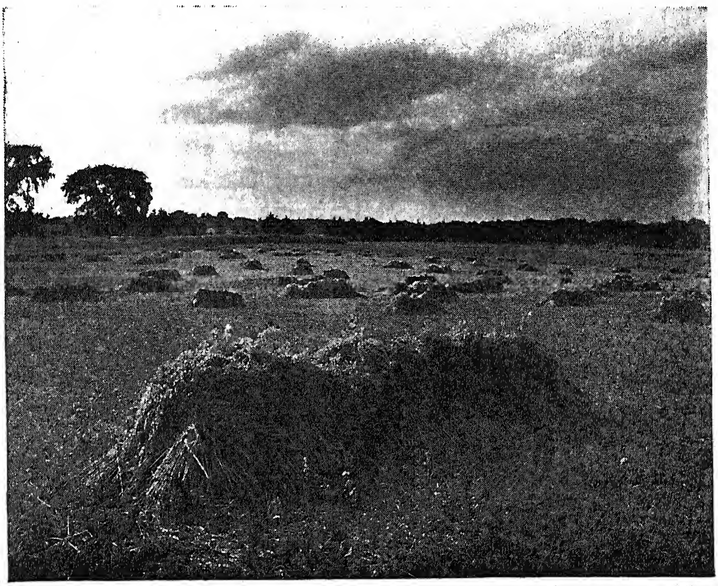
Oat Growing. Oats are best adapted to cool, moist regions and to fertile, moisture-holding loams, silt loams, and clay loams. The largest yields and heaviest oats are produced in northern regions.

The following are the operations of importance in oat growing:

1. Grow a high-yielding variety, adapted to prevailing conditions.
2. Fan seed oats to remove weed seeds, pin oats, dirt, and chaff.
3. Treat seed with formaldehyde to control smut.
4. Test germination of seed.
5. Plant early on a firm, well-surfaced seed bed.
6. Fertilize when necessary (phosphate is usually most effective).
7. Harvest when chaff and seed are yellow and seed is in the dough stage.
8. Cure in uncapped shocks.
9. Thresh from field or place in well-made stacks or in barn until threshing time.

Grow a High-Yielding Variety, Adapted to Prevailing Conditions. Oat varieties differ greatly in yield. A large number of oat growers secure low yields because they plant inferior varieties. Excellent work has been done by plant breeders in oat varietal improvement. Particularly in the Corn Belt states, Vicland, Vikota, Boone, and Tama have been popular varieties of oats. Since these oats have been developed recently, better varieties, Clinton, Forvic, and Cedar, are now available. The successful oat grower needs to keep in touch with nearby experiment stations to take advantage of the new varieties being released. Longer-seasoned varieties are best

adapted to northern states and Canada, whereas shorter-seasoned varieties are grown in the Corn Belt, so that satisfactory growth may be made before the prevailing hot, dry weather, which is typical of the midsummer seasons of the best corn areas.



Michigan Exp. Sta.

Oats shocked in field for curing.

Fan Seed Oats to Remove Weed Seeds, Pin Oats, Dirt, and Chaff. A good fanning mill cleans out light oats, pin oats, chaff, weed seeds, and dirt. In a short time its use may add enough bushels to the acre yield to pay for its cost. In oats, more than in other small grains, large, plump kernels show an increase in production.

Treat Seed with Formaldehyde to Control Smut. Oat smut causes great loss throughout oat-growing areas. This loss can be reduced to a small fraction of 1 per cent by the proper

treatment of seed oats with formaldehyde. Owing to the prevalence of oat smut and the likelihood of loss when seed is untreated, the formaldehyde treatment of seed oats should be included as a necessary practice wherever oats are grown. The concentrated formaldehyde treatment is considered most convenient in treating seed oats. This treatment is described on page 243.

Test Germination of Seed. After unfavorable seasons, the germination of oats may be poor, and many who plant at the usual rate will not secure the usual stand. The percentage of germination is very easily ascertained. A reliable germination test can be made if one hundred oat kernels are placed on a wet blotter or cloth between pie pans where the temperature is favorable for sprouting. After 5 or 7 days, the oats that have sprouted may be counted and the percentage of germinable oats readily figured. An increased rate of planting to offset dead or weak-sprouting seeds is advised if germination is less than 95 per cent; if very poor, other oats should be secured for seed. The same testers used in the germination test for corn may be used for oats.

Plant Early, on a Firm, Well-Surfaced Seed Bed. Oats are generally planted after such cultivated crops as corn, beans, beets, and potatoes. The land from which these crops have been harvested is, as a rule, comparatively free of weeds and in most instances can be fitted for oats by a thorough disking early in the spring. The earliest possible disking is recommended. Oats start best on a firm, well-settled seed bed with the surface worked into a condition of good tilth. Land that is clean after cultivated crops have been harvested can usually be put in this condition by thorough disking.

If the land is weedy, or cannot readily be worked into a condition of good tilth, fall plowing or early spring plowing to a medium depth is recommended. Fall plowing is particularly advisable under such conditions, since it gives time for the soil to settle thoroughly. If plowed in the spring, the ground should be thoroughly compacted with the roller imme-

diately after plowing and fitted with disk or spring-tooth harrow or cultipacker. Fall-plowed land should be disked as early as possible in the spring.

Oats thrive best on fertile loams and clay loams that are sufficiently charged with organic matter to carry moisture throughout the season. Light loams and sandy loams are inclined to be too droughty for high production. On muck soils and soils very high in organic matter, oats frequently lodge badly and fail to fill properly. Heavy clay lands can be put in condition for dependable oat production by tile-draining.

As a general rule, oats should be planted as early in the spring as the ground can be put in good condition. Late plantings usually yield less, because tillering or stooling is reduced and the crop heads out during the less favorable season of midsummer. Oats are favored by cool, moist weather and hence benefit by earlier planting. The usual rate of planting is 8 pecks per acre. When planted somewhat late, 10 pecks will give better results as stooling is not so vigorous. On heavy clay soils or soils very high in organic matter, such as muck lands, planting at the rate of 3 bushels or more has been shown to give higher yields than lighter seedings. Drilling gives better results than broadcasting and harrowing in. The seed should be planted at a depth of 1 inch on heavy soils and 1½ inches on light loams.

Fertilize when Necessary. In the Northern States and the Corn Belt acid phosphate or fertilizers high in phosphorus almost universally give a marked increase in yield when they are applied to land fitted for oats. Not only are the yield and weight per bushel increased, but the crop matures more uniformly and at an earlier date, and on heavy soils the tendency to lodge is overcome to a considerable extent. Apparently, the most profitable application ranges from 200 to 300 pounds of acid phosphate per acre, applied at the time of planting through fertilizer attachment on the drill, or broadcast when the seed bed is being fitted. Finely ground rock

phosphate or floats, used at the rate of 1000 to 1500 pounds per acre, also are effective in increasing oat yields.

On sandy soils, particularly those low in organic matter, ammoniated phosphate carrying nitrogen and phosphorus, or a complete fertilizer carrying nitrogen and potash in addition to phosphorus, such as a 4–12–4, may be used profitably at rates of 150 to 250 pounds.

Muck soils are usually markedly benefited by application of a fertilizer carrying potash and phosphorus, such as a 0–12–6, the usual application being 200 or 300 pounds per acre.

Manure is seldom applied directly to the oat crop, since it is usually applied to corn or another cultivated crop before oats and thus gives the greatest benefit to the oats. Heavy applications of manure, or direct applications when land is being fitted for oats, may cause considerable loss due to the lodging of the oat crop. On soils very deficient in organic matter, direct applications when the seed bed is being fitted for oats may be beneficial. On fertile lands, manure should be used on other crops in the rotation. The use of acid phosphate, in connection with manure, greatly increases its value.

Harvest Oats when the Chaff and Leaves Are Yellow and Seed Is in the Dough Stage. If allowed to remain in the field too long, the crop will lose its bright, fresh color. Damage will result from lodging and weathering. Harvesting too early results in shrunken grains, smaller yield, light weight per bushel, and poor color due to immaturity.

Cure in Uncapped Shocks in Field. As soon as cut with the binder, the sheaves should be set up in uncapped shocks to allow proper curing. The crop may remain in the field until threshing time if a thresher is readily available. A better quality of crop results if the sheaves are stored in well-made stacks or put under cover in the mow. An increasing number of farmers find that it pays to own their own thresher so that they can thresh from the field when weather conditions are right or from the stack or mow at a time of their own choosing. The home-owned thresher eliminates the possibility of

mixing varieties and of adding other grains and weeds from seeds carried by the itinerant thresher. Small types of combines are now in common use in threshing oats and other grains in the field in the Corn Belt and the Northern States.

Owing to the great speed and efficiency of harvesting and threshing in one operation, the use of the combine is increasing rapidly. The cost of harvesting is greatly reduced, but the combine does not work as satisfactorily with oats as with wheat. The straw crop may be left on the land or, if it is desired for bedding and feeding, the mower may be used on the long stubble and the straw raked with a hay rake.

Additional Information

Oat Types. Oats are commonly grouped according to the character of the head or panicle, time of planting, and color of the threshed grain.

Spreading or open-panicle oats carry their kernels on spreading branches equally distributed about the central stem or rachis. Close-panicle oats have the seed on shorter branches held close to the central stem. Horse-mane or side oats carry the oats compactly on one side of the stem.

Spring oats, that is, oats planted in the spring, occupy the majority of the acreage. Only spring oats are planted in northern regions.

Winter or fall-planted oats are the common oats of southern states.

A wide range of color is represented in American oat varieties. White oats are the most widely grown and most highly esteemed on the market. Yellow oats, represented by the short-seasoned oats of the southern and central Corn Belt, rank next. Black oats are discriminated against in the market. Red oats are commonly grown in Texas, and gray or dun-colored oats in other southern states.

Hull-less oats do not yield well generally and are little grown.

Origin and History of Oats. It is not known when oats were first cultivated. They became important as a feed crop in Europe during the Middle Ages, but there is evidence that they were used by the prehistoric peoples of that region. Oats were an important crop of the early colonists of America.

Importance and Use. Oats occupy third place in the small-grain acreage of the United States, being exceeded by corn and wheat. They are known as the best grain feed for horses and are widely used in feeding other livestock and for human consumption, chiefly as oatmeal.

Barley Growing. Barley occupies fourth place among American cereal crops. It is grown to greatest extent in the Northern States, Canada, and California; the best yields are on fertile loams in regions of rather cool, moist seasons. It is the chief grain feed of regions north of the Corn Belt and is coming into greater use in the northern Corn Belt as a feed that is available early for fattening hogs. Its use as a feed grain is increasing as more farmers understand barley production and feeding methods.

The operations in barley growing are:

1. Choose best variety.
2. Fan seed and treat with formaldehyde.
3. Prepare a firmly compacted, well-surfaced seed bed.
4. Apply the right fertilizer for your soil.
5. Plant in early spring.
6. Harvest when mature, cure, and thresh from well-made stacks or from barn.

Choose Best Variety. Improved barley varieties show great superiority in yielding ability over common seed of unimproved varieties. In areas where barley growing is important experiment stations are developing and testing strains and varieties of barley. In many regions the fact that the old varieties of barley have been attacked by diseases made it necessary to develop new disease-resistant, high-yielding, and good-quality barleys. As an example, the Minnesota Station

has introduced a new variety called Mars. This variety has stiff straw, earliness, stem-rust resistance, high weight per bushel, and high-yielding ability. New and improved varieties of winter barley have been developed. In southeastern Pennsylvania winter barley has yielded much more than spring-planted varieties. The brewing industry considers the Oderbrucker an excellent malting barley. Two-row, smooth-

Michigan Crop Imp. Assn.

A barley field being inspected for seed certification

bearded spring varieties such as the Spartan of the Michigan Station and the Glabron of the Minnesota Station give excellent results in northern states for feed purposes.

Fan Seed and Treat with Formaldehyde. Seed barley should be thoroughly cleaned with a fanning mill to remove cracked kernels, dirt, and seeds of noxious weeds. After cleaning, the barley is treated with formaldehyde to control the covered smut of barley and the leaf stripe. These diseases cause great loss in regions where barleys are not treated. The concentrated formaldehyde treatment, recommended for oats, gives excellent results with barley. (See Chapter XV.)

A test should be made of the germination of seed and, if the germination is below 95 per cent, the rate of planting should be increased proportionately or new seed secured.

Prepare a Firmly Compacted, Well-Surfaced Seed Bed. Barley ground should be prepared as early as possible in the spring. After a cultivated crop, such as corn, beets, or potatoes, a thorough disking in early spring, followed by the use of a cultipacker or spike-tooth harrow, should put the ground in good shape for barley. Weedy ground should be plowed to medium depth, rolled with weighted roller or cultipacker, and harrowed. Barley needs a seed bed with the lower part of the furrow slice thoroughly compacted, and with the surface worked into a good condition of tilth.

Apply the Right Fertilizer for Your Soil. Barley responds to the use of fertilizers that are high in phosphorus. On soils which have been manured or where clover sod has been turned under, 200 or 250 pounds of acid phosphate, at time of planting, give excellent results in increasing yields and in hastening maturity. On soils deficient in fertility, the use of a complete fertilizer, such as a 4–12–4, is advisable.

Plant in Early Spring. Best results are secured by planting barley as soon as the planting may be made in early spring. Late plantings are more subject to damage from summer heat and drought. On heavy land, the seed should be planted at a depth of 1 inch; on lighter loams, 1½ inches. Barley is best adapted to fertile, well-drained loams, and clay loams of the Northern States and Canada.

Harvest when Mature, Cure, and Thresh from Well-Made Stacks or from Barn. Barley is ready to harvest when the chaff and leaves are yellow and the seed is in the dough stage. The crop should be cured in the field, and, if a thresher is available and other conditions right, threshing may be done from the field. Frequently, however, it is better practice to store until threshing can be done from large, well-made stacks or in the barn. Grain of a brighter color and of higher quality usually results when barley is threshed from large stacks or from the barn.

Additional Information

History and Importance of Barley. The use of barley by man apparently antedates our earliest recorded history. The Egyptians used it for bread making and beer making before 3000 B.C. It was the most important bread grain of Central Europe during the Middle Ages.

In the northern tier of states, in California and Kansas, and in Canada, barley is an important grain crop for feeding purposes and for market.

Types of Barley. The barleys are classified according to the number of rows of grain in the spike or head, the character of the beard, or awn, the presence or absence of the hull after threshing, color of the grain, and time of planting.

Spring barleys are grown in northern states, winter barleys in California, south of the Ohio River, and Maryland.

The six-row bearded, hulled type is most commonly grown in the Northern States and Canada. The Oderbrucker and Wisconsin Pedigreed are leading varieties. Two-row bearded, hulled types are coming into favor in these regions. The long, slender heads cause a deceptive impression of the yield in the field; but yield tests show new, improved two-row barleys, such as the Alpha of New York and the Michigan Two-Row, to be high yielders.

In the hooded barleys, commonly called beardless, the beard or awn, is shortened to a blunt, compact structure. Recently the United States Department of Agriculture distributed a true beardless barley. Hull-less or naked barleys, grown chiefly in the irrigated districts of the Rocky Mountain region, thresh clean like wheat.

Smooth-bearded barleys, like the Michigan Two-Row, have barbless beards. This type is meeting with some favor as a feed barley and where barley straw is used for bedding or where barley is fed on the farm in the sheaf by those who do not like to handle the common barb-bearded types.

White is the common color of barley grains; but yellow, blue, purple, and black barleys are grown.

Buckwheat Growing. Buckwheat is utilized frequently as an emergency crop to be grown where other crops have failed. It is one of the shortest-seasoned grain crops, maturing in 60 to 80 days. Buckwheat is valuable as a grain crop, a honey crop, a green-manuring crop, and a cover crop. Green buckwheat is a good source of rutin. This material is used for medicinal purposes in controlling high blood pressure. In some areas, therefore, it is to be expected that processing plants will be established to handle the production of this material. The popularity of buckwheat cakes and the recent development of buckwheat groats, a new breakfast food, may result in greater production of buckwheat. As a feed, grain buckwheat has long been held in high esteem by poultrymen, but it constitutes only a small percentage of the total feed. Buckwheat is adapted to a wide variety of soils and climatic conditions. In growing buckwheat the following operations are the most important:

1. Secure good seed of the best variety.
2. Prepare seed bed properly.
3. Plant at right time and depth.
4. Harvest when the majority of seed is ripe.
5. Cure in open shocks; handle with fork in loading for threshing when buckwheat is slightly damp with dew.

Secure Good Seed of the Best Variety. The Japanese, the Silver Hull, and the Gray are the leading varieties of buckwheat commonly grown. The Japanese is the largest-growing type and produces a larger seed than the Silver Hull or the Gray. The seed of Japanese buckwheat is black. This variety gives the highest yields under good conditions.

The Silver Hull has a smaller seed, and the plant is considerably smaller than the Japanese. This variety is shorter-seasoned and is not affected quite so much as the Japanese

by extremely hot, dry weather, which causes blasting of buckwheat flowers. The Gray is very similar to the Silver Hull.

Many growers mix the Japanese with either the Gray or the Silver Hull and claim that larger yields result during adverse seasons.

Buckwheat seeds should be whole, plump, free from mixture with weed seeds, and of good odor and high germination.

Prepare Seed Bed Properly. Buckwheat is usually planted after a failure of corn, beans, beets, or other early planted crop. Little attention is commonly given to refitting the seed bed, but it will pay to disk the land thoroughly and work with harrow and cultipacker before the land is reseeded to buckwheat. This crop is also planted on poorly prepared seed beds, which cannot be brought into proper condition to receive other cultivated crops. Although it will give a good account of itself under these conditions, best yields are secured by plowing and fitting the seed bed as for oats or barley.

Fertilizer is seldom applied to buckwheat, but acid phosphate at the rate of 250 pounds, or a dressing of manure, or both, will give great increase in the yield of buckwheat.

Plant at the Right Time and Depth. Buckwheat should be planted when the seed bed is well warmed. The seed of buckwheat will start on comparatively hot, dry seed beds under conditions where common field seeds fail to germinate. The crop may be planted as late as the first of July in northern states, or the middle of July in Corn Belt states, but larger yields are secured by planting in May or early June. For green-manuring purposes, or to prevent erosion in orchards or on hillsides, or as a companion crop with summer seedings of alfalfa on light soils, buckwheat may be seeded in late July or early August. It is usual to plant 2 to 5 pecks per acre, 3 pecks being the average rate. The seed should be planted at a depth of 1 or 2 inches.

Harvest when the Majority of Seed Is Ripe. Buckwheat is intermittent in its ripening period; that is, all the blooms do not ripen into seed at the same time. Judgment should be

used in cutting the crop for curing at the time when most of the seeds are ripe and when large loss will not occur from shattering. Buckwheat is usually ready to harvest in 60 to 80 days after planting. A mower, with buncher attachment, binder, or cradle is usually employed. Buckwheat should not be cut when the crop is dry; as far as possible, the crop should be cut in the early morning or on damp days to prevent shattering.

Cure in Open Shocks; Handle with Fork in Loading for Threshing when Slightly Damp with Dew. Buckwheat should be cured in small, uncapped shocks. The stems and seeds carry an unusual amount of moisture; hence capping results in loss from mildew. After curing for several days or a week or more in the field, the crop is ready for threshing. If the ordinary grain separator is used, the crop should be hauled in from the field in the early morning and stacked for threshing to prevent the great loss of buckwheat grain which would occur if the grain were stacked when very dry, in mid-day, or in the afternoon.

General Information

History and Importance of Buckwheat. Buckwheat is of ancient Chinese origin and was unknown in European countries before the fifteenth century. In the United States, buckwheat has been grown since early colonial times.

It is a minor crop even where the greatest acreage is grown, in New York, Pennsylvania, West Virginia, Michigan, and Wisconsin. Its chief uses are the making of buckwheat flour and the feeding of livestock and chickens. During war times the production of buckwheat increases greatly.

Flax Growing for Feed and Fiber. Flax is grown chiefly for seed purposes in the United States and Canada. It is usually the first crop grown on newly turned sod lands in the Northwestern States and in western Canada.

The production of seed flax is of greatest importance in

North and South Dakota and adjoining areas of neighboring states. During recent years seed-flax growing has increased extensively in the Imperial Valley of Southern California. The production of fiber flax is limited to several thousand acres in Oregon and in eastern Michigan and Ontario, Canada. The seed is used in the making of linseed oil and oil feed, and the fiber flax is used in the manufacture of linen thread and tow. Flax hurds (the straw remaining after the seed is threshed) are used as a roughage and to some extent in making coarse tow for toweling, bagging paper, rugs, and insulating material for buildings.

Flax for Seed. The operations in producing flax for seed are:

1. Get wilt-resistant variety and treat seed with formaldehyde.
2. Prepare seed bed.
3. Plant early in spring.
4. Harvest for seed when fully mature.
5. Cure in field and thresh.

Get a Wilt-Resistant Variety and Treat Seed with Formaldehyde. Great losses are caused by wilt. This disease is controlled by planting wilt-resistant varieties, such as Bison, Linota, Newland, and Reserve, lately produced by experiment station plant breeders in flax-seed producing states, by treating seed with formaldehyde, and by growing flax on newly turned land or in a long rotation which brings flax on the land every 7 or 8 years. (Formaldehyde treatment, Chapter XV.)

Prepare Seed Bed. Plowing should be done in early spring or fall. Flax is usually planted on the first breaking of new ground. It will give a comparatively good yield on fresh-turned sods, plowed to shallow depth, but best yields are secured if a seed bed is prepared in the same way that ground is fitted for oats or barley.

Plant Early in Spring. Early plantings give best yields. Late plantings suffer loss in yield because the plants are subjected to the hot weather of summer during the early

stages of growth. Usually 2 pecks of seed per acre are drilled with an ordinary grain drill.

Harvest for Seed when Fully Matured. Flax is harvested for seed when the seed balls are brown and the eight or ten flax seeds in each are well developed. The grain binder is used in harvesting, and the flax is cured in open shocks or, under favorable conditions, threshed immediately.

Cure in Field and Thresh. Threshing is done from the field with an ordinary grain separator, usually operated by an engine equipped with a straw burner which burns flax straw for power. The straw accumulated has value as a roughage for cattle and for the manufacture of coarse fiber products, but is often burned. Yields of 12 to 15 bushels per acre are considered excellent.

Flax and Oat Mixtures. The planting of flax and oats together in the ratio of 1 peck of flax to 1 bushel or 6 pecks of oats is gaining in northern and northwestern states.

Both plants reach maturity at about the same time and are threshed together, and the grain is separated with a fanning mill. Yields of oats little below normal are secured, with 3 to 6 bushels of flax per acre in addition.

When linseed meal and oil meal are very high in price, dairymen in northern states secure a cheap source of flax seed for feeding by growing several acres of flax and oats. One cupful of whole flax is usually given each cow per feeding.

Flax for Fiber. Ordinarily, fiber-flax production in the United States is limited to several thousand acres in Oregon and much smaller acreages in Michigan and Minnesota. During World War II, flax production was expanded in Oregon to more than 12,000 acres in order to produce fiber for parachute cords, thread for sewing leather, and tough fiber for other purposes increased by the demands of war.

Special long-stemmed varieties such as the Saginaw must be grown for fiber. The crop should be planted on well-

drained, fertile, moisture-retentive soils which have been fall-plowed and well fitted, or it must follow a cultivated crop.

Two bushels of seed are drilled per acre. The crop is harvested by pulling by hand or by machine, when the seed balls are formed and beginning to turn brown. Flax is cured in the field in open shock, and the seed is removed in a special hand thresher which strips the seed without injuring the fiber. The stems are then spread out for retting and the fiber secured by a special manufacturing process.

SUGGESTIONS

1. Secure from the state agricultural college or agricultural experiment station information on oats, barley, buckwheat, and flax. If these crops are of importance on home farms, study the information secured with a view to selecting the best varieties.

2. If any of these crops is important on home farms, study their production carefully for the purpose of making improvements. The introduction of new strains, disease-free seed, efficient methods of fertilization, for example, may make an important difference in the profitableness of the enterprises.

3. Make a study of prices, market classes, and grades of these grains.

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CHAPTER XXII

SORGHUM GROWING

The sorghums have opened up a great region west and southwest of the Corn Belt to profitable crop and livestock production.

The grain sorghums, Milo, Kaffir, Higari, Durras, and others, are adapted to regions of comparatively light and poorly distributed rainfall where corn is not dependable. Unlike corn, they have the faculty of furling their leaves and remaining dormant during periods of severe drought, coming into growth again when rains occur. They are grown chiefly in the northwestern quarter of Texas, western Arkansas, Kansas, Nebraska, Colorado, Arizona, California, and New Mexico, in regions of 15 to 30 inches of rainfall.

From 1899 to 1945, the acreage of grain sorghums increased from less than 300,000 to more than 6,000,000.

During the great droughts of 1934 and 1936 the sorghums and Sudan grass increased greatly in use and proved their remarkable value as compared to other crops in coping with drought conditions.

The sorghums include the non-saccharine or grain sorghums, the saccharine sorghums, broom corn, and Sudan grass.

The operations to consider in growing the sorghums are:

1. Grow the right variety.
2. Treat seed with formaldehyde.
3. Plant in a well-warmed seed bed at right date and depth.
4. Give clean cultivation.
5. Harvest when seed is ripe.

Grow the Right Variety. As with corn, there are a great number of grain sorghum varieties of widely varying yielding ability and adaptation. The Kaffir group is characterized by compact, leafy stalks and erect heads. Leading varieties are the Black Hull, White, Red, and Pink.

U.S.D.A.

Harvesting grain sorghum. This crop grows thriftily in regions west of the Corn Belt where rainfall is deficient for successful corn growing.

The Durras or Milos are smallest and less leafy, with either erect or drooping heads. The leading varieties are the Standard and the dwarf Milo and Feterita.

The Koaliangs are earlier in maturing, smaller and less leafy than the Kaffirs.

The experiment stations of Texas and Kansas and other states growing grain sorghums have developed specially desirable strains such as Martin's Early Combine and Midland.

In some areas and under certain conditions the forage sorghums and Sudan grass produce hydrocyanic acid which kills livestock eating such forage. In areas where this danger exists varieties should be used which have a low content of this acid. A variety called Rancher developed by a plant

breeder and produced by the South Dakota Experiment Station is an example of a sorghum with a low-acid content; it can be grown under all conditions and fed to livestock with safety.

Martin's Early Combine, developed in Texas, is a high-yielding, early-maturing combine type of grain sorghum that is widely grown from Nebraska to Texas. Midland, a week or so earlier than Martin's, higher-yielding and chinch-bug-resistant, was released from the Fort Hayes Kansas Experiment Station in 1944 and may result in material expansion of the grain sorghum belt.

Treat Seed with Formaldehyde. The grain sorghums are susceptible to smut; hence seed should be treated with the standard formaldehyde solution. (See Chapter XV.)

Plant on a Well-Warmed Seed Bed at Right Date and Depth. The seed bed for grain sorghums is prepared in a manner similar to the preparation of the seed bed for corn. Planting time is usually a week to two weeks later than for corn and ranges from May 1 to June 15.

The grain sorghums are planted in rows 36 or 42 inches apart, the seed being dropped 4 to 8 inches apart in the rows at depth of 2 inches. From 3 to 4 pounds of seed are used per acre. A corn planter with sorghum plates is used.

Give Clean Cultivation. As with corn, clean intertillage is necessary. Usually 3 to 5 cultivations are given.

Shallow, surface cultivation gives best results.

Harvest when the Seed Is Ripe. Most varieties are harvested when the seed is fully ripe. Those that shatter easily are harvested when the seed is in the tough-dough stage; this is also done when the crop is to be used for ensilage.

The crop is usually harvested with a corn binder or headed with a grain header and threshed through a grain separator.

The Saccharine or Sweet Sorghums. The sweet sorghums are grown chiefly for forage and syrup. They have a juicy pith, which is high in sugar content. The sweet sorghums are grown mostly throughout the Southern States and to a considerable extent in the Corn Belt.

Sweet sorghums increased greatly under the home food and feed program encouraged in the South by the Agricultural Adjustment and Soil Conservation program. In southern regions, varieties of ribbon cane are used more extensively than the sweet sorghums.

The operations are:

1. Grow the right variety.
2. Plant when seed bed is well warmed.
3. Harvest when seed is in dough stage for syrup and ensilage.
4. Haul immediately to press.
5. Press juice, clarify, and make syrup.

Grow the Right Variety. In southern regions the Sumach variety is the most widely grown. In the Corn Belt and Northern States the Early Amber is the best adapted.

Plant when the Seed Bed Is Well Warmed. Plant about 10 days or 2 weeks after corn. The seed bed is prepared as for corn, and a corn planter with proper plates is used in planting. For syrup and forage, 6 to 8 pounds of seed is drilled, in rows 36 to 42 inches apart. The crop is cultivated like the corn crop, particular attention being given to seed-bed fitting and early cultivations because of the slow early growth of sorghum.

Harvest when Seed Is in the Dough Stage for Syrup and Ensilage. If the crop is harvested for forage or ensilage, the corn harvester is usually used, and the harvested crop is hauled immediately to the cutter.

For fodder purposes, sorghum is often drilled thick, harvested with binder, when seed is just forming, and cured in open shocks in the field.

If the crop is harvested for syrup, particular care is necessary. Sorghum increases in percentage of sugar as well as total dry matter until it is mature. From early-dough stage until hard-dough stage, it is right for syrup making. If the seeds become hard, there is danger of frost before all the canes are made up, whereas, if the seeds are in the milk stage, an acid

syrup with an unripe taste is produced. For best results, leaves are stripped while canes are standing. The seed head with 6 to 8 inches of the upper cane should be cut off, as this part contains many impurities. Suckers should be discarded for the same reason. Canes may be cut by hand or with the corn binder. In warm weather canes should not be cut more than 2 days before they are to be used, as there is danger of fermentation. When a heavy frost occurs the sorghum should be cut and placed in large shocks at once. A heavy freeze will do little damage provided the canes can be worked up at once upon thawing, but after thawing they will spoil in a very short time. A ton of canes will yield 500 to 1000 pounds of juice, which will make 8 to 25 gallons of syrup. From 4 to 8 tons of canes per acre is a good yield.

The Manufacture of Syrup. This consists of three main stages: (1) extraction of juice; (2) clarification of raw juice; (3) evaporation of juice. The extraction is done by passing the cane between rollers. The canes are 70 to 80 per cent water, but it is not possible to obtain all of this as juice. With a three-roller mill, 50 per cent of the weight of the cane should be obtained unless the cane is very hard and dry. The canes, after being passed through the mill, can be used for roughage. Often they are put in the silo either with corn or alone. The juice, as it comes from the mill, should be run through a strainer made of fine wire (such as is used for milk strainers) into a settling tank or barrel, in which it is later stored. There should be three tanks, one being filled while one is being emptied and the third is settling. Raw juice holds in solution a number of impurities which on standing settle slowly to the bottom. These impurities are good hog feed. Some makers provide special tanks and clarify by heating. The temperature of the juice is brought nearly to the boiling point, the heat is turned off, and the juice is allowed to stand for a short time; then the clear layer is drawn off for evaporation. This process is preferred, since heat hastens clarification.

Growing Broom Corn. Broom corn, from which ordinary floor and whisk brooms are made, is grown chiefly in Illinois, Kansas, and Iowa, but follows the corn crop in adaptation.

The early colonists of Pennsylvania made crude brooms from a wild variety,[1] but it is reported that Benjamin Franklin, observing seed adhering to a broom straw of a broom imported from Europe, carefully preserved and planted the seed and started the manufacture of brooms.

The Standard, or long-brush type, is grown chiefly in Illinois, the Dwarf or short-brush type in Kansas.

The crop is planted and cultivated in a manner similar to the culture of corn. Two or 3 pounds of seed per acre are drilled in rows 42 inches apart.

Broom corn is harvested when in the milk or early dough stage. The larger-growing standard type is "tabled" in the field, the stalk being broken over at a height of 2½ feet from the ground. Two rows are broken inward at a time, and the brushes protruding at the sides are cut off, the seed threshed with a special thresher, and the brushes placed under drying sheds to cure. The Dwarf broom corn is harvested in the field by pulling out the brushes. After the crop is cured, it is graded and baled for market. Long brushes of uniform straws are most desirable.

SUGGESTIONS

1. What varieties of sorghum are grown in your locality? For what purpose?
2. Get information on best yields and how they were secured.
3. Is loss from sorghum smut prevalent? How controlled? How many employ this method?
4. Get best varieties obtainable and test on your farm or with local cooperator.
5. Do growers of your neighborhood practice head selection of sorghum or broom corn to improve yield and type? Describe types of heads or brooms selected.

[1] Carrier, *Beginnings of Agriculture in America,* McGraw-Hill, 1923.

6. Get leading types and varieties and study characteristics of head and seed.

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CHAPTER XXIII

GROWING SOYBEANS AND COWPEAS

It takes about a generation to establish a new crop.

C. E. Thorne

Soybeans. During the past two generations interest in soybeans has increased greatly. This crop has made more rapid strides proportionately, in acreage increase, than any major seed-crop grown in the United States during the past thirty years. The use of this crop on the "adjusted acreage" in the A.A.A. Corn Control Program in 1935, at a time when industrial and feeding use of soybean products expanded and feed was needed after the great drought of 1934, caused an increase of nearly 50 per cent in acreage.

The many uses of soybeans, particularly the value of the crop as a leguminous feed and in soil improvement and the use of soybean oil and meal for many manufactured products and for human and livestock feed, have caused it to develop from a minor crop to a crop of importance in most corn-growing states. During World War II, soybean production was greatly expanded to produce needed oil and protein for livestock and human beings. Soybeans are grown as a grain and seed-crop, as a hay crop, with corn for ensilage and hogging-off, for green-manuring, as a protein concentrate, and as an oil-producing crop. They are adapted to practically all well-drained soils in regions where the season is suited to growing corn for grain.

The practices described below insure the successful production of soybeans.

1. Grow a variety adapted to your soil and climate and to the purpose for which the crop is grown.
2. Prepare the seed bed thoroughly.
3. Plant at right date on a well-warmed seed bed; inoculate when necessary.

Indiana Exp. Sta.

A well-cultivated field of soybeans.

4. If planted in rows for seed or grain cultivate thoroughly, as corn is cultivated.
5. Harvest crop for seed or grain when mature and before the shattering stage is reached.
6. Cut for hay when pods are well formed and beginning to fill, and before the lower leaves turn yellow and drop.

Grow a Variety Adapted to Your Soil and Climate and to the Purpose for which the Crop Is Grown. There is a great range in the climatic adaptation of soybean varieties, in habits of growth, and in yielding ability. For seed purposes, Lincoln, Illini, Manchu, and Mid-West are leaders throughout the Corn Belt. In Virginia, Wilson and Virginian are preferred.

These varieties are also used for hay and hogging-off, but in the same region Wilson and Manchu are preferred for hay purposes. In Michigan, Wisconsin, and Minnesota, Manchu, Wisconsin Early Black, and Minsoy are grown for both grain and forage. For forage only, Manchu is preferred. In the southern part of the Corn Belt and Southern States, Mammoth Yellow and Wilson's Early Black are leading varieties.

Prepare the Seed Bed Thoroughly. The seed bed for soybeans should be prepared in much the same manner as the seed bed for corn and field-beans. Ground plowed in the fall or early spring can be put in much better shape for soybeans than ground plowed late in the spring. The seed bed should be prepared by a thorough disking and harrowing and should be rolled with a cultipacker or bar-roller before planting.

Plant at Right Date in a Well-Warmed Seed Bed. Soybeans should be planted during the latter part of corn-planting time or immediately after. They start best on a well-warmed seed bed. For green-manuring, they may be planted several weeks later. May 20 to June 15 is the usual range of planting time throughout the Corn Belt and the Northern States. Soybeans should be planted at a shallow depth, not more than 1 inch. If a crust forms before the beans have appeared above the ground, the ground should be harrowed lightly with a spike-tooth harrow or a cultipacker should be used.

When soybeans are planted in the field for the first time, they should be inoculated with proper culture or with soil from a successful soybean field.

For seed, soybeans should be drilled in rows 28 to 30 inches apart. A corn drill with proper plates, or an ordinary grain drill with every fourth cup open, should be used. Two or 3 pecks of seed per acre are sufficient.

When soybeans are planted with corn for ensilage and hogging-off, they should be planted by means of a special soybean attachment for the corn planter. This attachment is a separate drill. Usually 6 or 8 quarts per acre are planted with corn.

The practice of mixing corn with soybeans and drilling the

two together is not desirable, since the resulting stand of corn may lack uniformity, and the yield may be decreased.

When planted for hay and green-manuring, soybeans may be planted in rows 28 inches apart or drilled with an ordinary grain drill, the drill holes being allowed to remain open and producing rows 7 inches apart. The last method will usually produce more hay on well-prepared land, and the hay secured will be finer stemmed and more leafy. From 4 to 7 pecks of seed are used per acre.

If Planted in Rows for Seed or Grain Cultivate Thoroughly, as Corn Is Cultivated. Soybeans should be cultivated with an ordinary corn cultivator as soon as the rows can be followed. Three or four cultivations are usually necessary. The first cultivation may be fairly deep and close to the row, but later cultivations should be shallow to prevent root pruning.

Harvest Crop for Seed or Grain when Mature and Before the Shattering Stage Is Reached. When soybeans are grown for seed, harvest should start when the pods have reached maturity. Either the mowing machine or the grain binder may be used. Soybeans should be handled during the early morning when damp with dew, to prevent shattering. When cut with the mower, the plants are gathered into windrows and then into small cocks for curing.

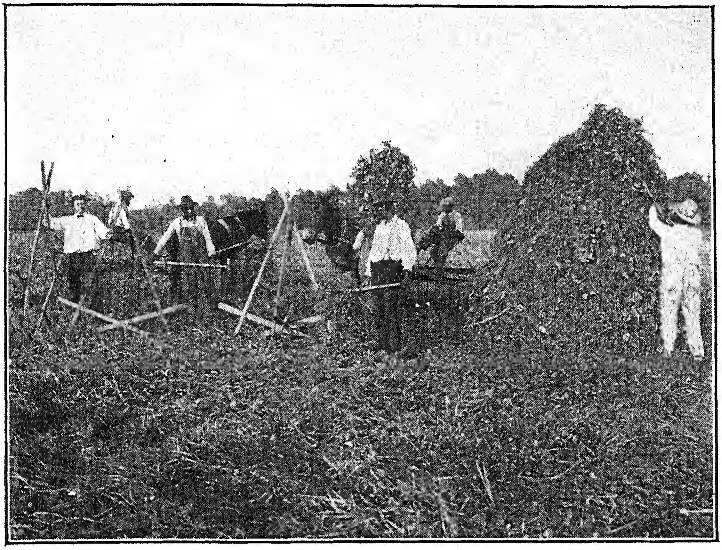
If a grain binder is used, soybeans are tied in small bundles and placed in open shocks. When cured, the beans may be threshed direct from the shocks or put into stacks. They may be threshed through an ordinary grain separator with cylinders running at half speed, or through a bean separator.

Yields of 20 to 30 bushels are considered excellent. The average yield of soybeans is about 15 bushels per acre.

Cut for Hay when Pods Are Well Formed and Beginning to Fill, and Before the Lower Leaves Turn Yellow and Drop. When grown for hay, the crop should be harvested when pods are beginning to fill and before the leaves turn yellow and begin to drop off. If cut too early, the yield of hay is reduced,

and difficulty in curing may result. If cut too late, the stems become woody, and much loss may result.

The hay should be cut when the dew is off and raked into windrows in late afternoon or the next day. After curing one or two days in windrows, the crop may be stacked or put in



U.S.D.A.

Cowpeas and soybeans can be efficiently cured in rainy seasons by use of collapsible curing racks.

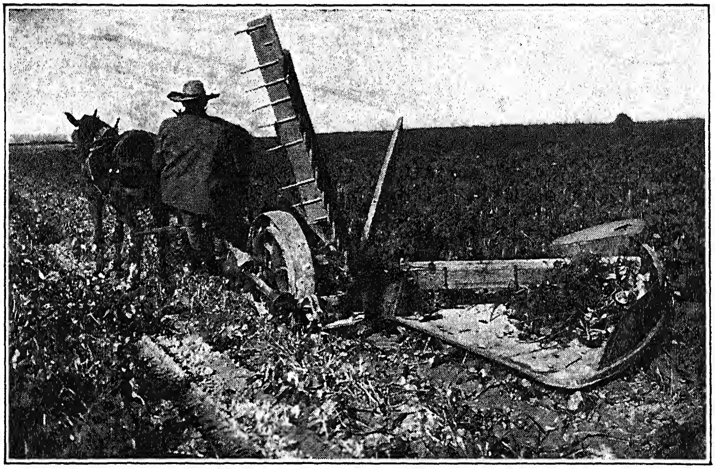
the mow, if weather conditions have been favorable. If curing is slow, the windrows should be cocked, and curing allowed to take place in the cock until the crop is in condition to put in stack or mow.

Additional Information

Soybeans are not so sensitive to acid or sour soils as clover and alfalfa; hence their use has become more general in regions where soil acidity places alfalfa, clover, and sweet clover

on a precarious basis. On extremely acid soils it may be necessary to lime in order to get soybeans; 2 or 3 tons of finely ground limestone is recommended.

A remarkable industrial demand has recently developed for soybean products, and chemists are constantly developing new uses.



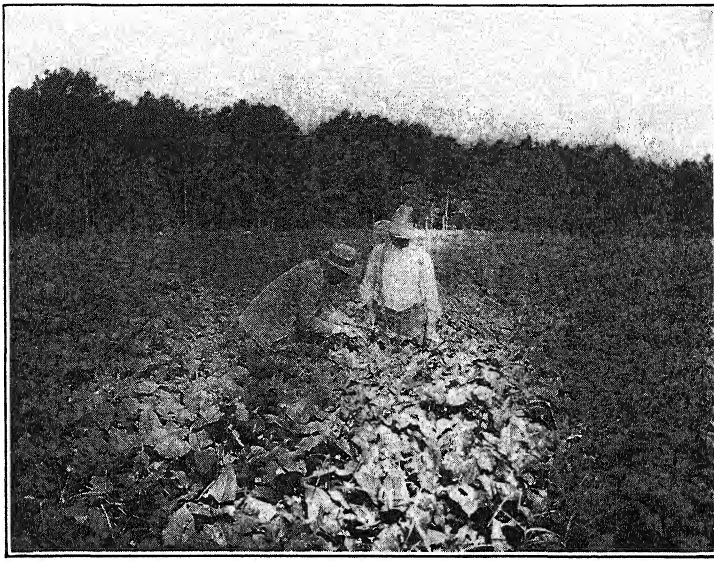
U.S.D.A.

Harvesting cowpeas for seed.

The oil and meal of the soybean are now used for many parts in automobile construction, such as gear-shift handles, battery cases, distribution housings. The oil is used in paints and lacquers and in food oils for human consumption. Soybean meal is now an important human food used in making bread and pastries and is a leading protein concentrate in dairy and livestock rations. The possibilities of further development in the uses of this versatile crop are exceedingly promising.

Cowpeas. The cowpea is of particular importance in the South, though adapted varieties are grown to a considerable extent in the southern part of the Corn Belt. It is a warm-

weather crop, very susceptible to frost. It is indeterminate in its growth, producing flowers and mature beans until growth is stopped by frost. The cowpea is well established where adapted as a valuable soil-improving legume and as an excel-



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Cowpeas are an important soil-building, forage and feed crop in the Cotton Belt.

lent forage crop for hay and pasture. The seed of cowpeas furnishes valuable feed for livestock, and some varieties, particularly the Black-Eye, are used extensively for human consumption.

Cowpea Varieties. The leading varieties of cowpeas grown for forage and soil improvement are Whippoorwill, Iron, New Era, and hybrids of these varieties, Groit and Brabham. The Black-Eye variety is used for forage, soil improvement, and as a table variety.

Planting Cowpeas. Cowpeas are usually planted in rows 3 feet apart with seed every 2 or 3 inches, 40 pounds an acre, or they may be drilled solid at rates of 1 bushel or 1½ bushels per acre (60 to 90 pounds). Plantings should begin when the ground is well warmed, in May or early June. When they are grown for seed, cowpeas are usually grown in rows and given thorough cultivation. Seed yields usually average 4 or 5 bushels per acre. When grown for hay they are usually drilled solid. Cowpeas are frequently planted at the time of the last cultivation of corn, 1 bushel or 1½ bushels per acre being broadcast.

Curing Cowpeas for Hay. Owing to the succulence of the vines, cowpeas are more difficult to cure for hay than soybeans. They should be cut with the mowing machine when the pods begin to turn yellow. After wilting in the swath the hay is raked into windrows and allowed to cure for 1 or 2 days. The hay is then forked into high narrow cocks, usually around frames built for the purpose. The hay is considered equal to red clover hay if properly cured.

SUGGESTIONS

1. For what purposes are soybeans grown in your locality? Get samples of varieties from a number of growers. Study characteristics of each.

2. Visit best growers, preferably at harvest time. Note variety and method of harvesting. Inquire about manner of fitting soil, planting time, rate and method, cultivation, and so on.

3. Get peck samples of leading varieties and conduct a varietal test on your farm or that of a cooperator.

4. How many growers plant with corn for ensilage? Get their opinion on feeding value.

5. Secure lots of seed to be planted in your neighborhood. Study characteristics.

6. Secure samples of cowpea varieties grown in your locality.

7. Do local farmers use cowpeas for hay or pasture?

8. After a crop of cowpeas has been grown on the land, what is the effect on following crops of corn, cotton, or other cultivated crop?

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CHAPTER XXIV

GROWING THE CLOVERS

The clovers, where adapted, are foundational crops in farm rotations. They increase humus and nitrogen in the soil, prevent erosion, and provide high quality hay and pasture.

The clovers are the standard leguminous crops for hay, pasture, seed, and soil improvement in the rotations of the Corn Belt and Northern States. Land that grows good clover is generally recognized as fertile land, and successful fields of clover are almost invariably followed by increased yields of corn, potatoes, beans, beets, and grain crops grown in rotation. The successful growing of the clovers is generally accompanied by profitable livestock production.

Types of Clover. *Red clover* is the most important of the clover family. It is a biennial crop and furnishes excellent yields of high-quality hay and valuable pasturage. *Mammoth clover*, or sapling clover, is a large-growing type of red clover.

Alsike clover is second in importance to red clover. It will do better than red clover under adverse soil conditions such as wet or slightly acid soils. The bloom of alsike is pinkish and smaller than red clover. Seed of alsike is much smaller, and hence much less seed is required per acre in planting. Alsike is important for both hay and pasture. It is a short-lived perennial.

White clover or Dutch clover is important in pastures. It is a small-growing, decumbent, long-lived perennial that withstands tramping, enriches pastures, and furnishes an excellent yield of highly nutritious pasturage. Wild White clover is an English variety of white clover that is more hardy than the

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Red clover has long been the foundational crop of Corn Belt rotations.

white Dutch clover. Wild White clover is important in American pastures.

Ladino is a large-growing type of white clover that provides much more pasture per acre and is valuable for hay. Ladino is a native of northern Italy. The crop requires an ample supply of rainfall or water supplied by irrigation. Ladino seed is produced in Oregon, California, and Idaho.

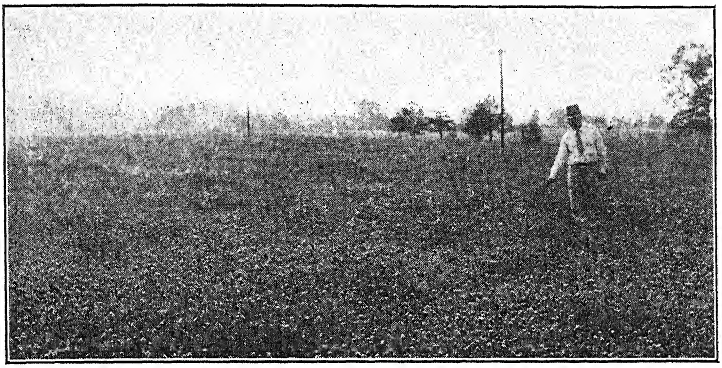
Ladino has become important for pasture purposes in New England and New York, and its use is increasing rapidly in the states bordering on the Great Lakes and in the Corn Belt. It is planted in the spring at a rate of 1 or 2 pounds per acre mixed with orchard grass, redtop, timothy, bluegrass, and with alsike and red clover, or it may be seeded in early spring on established grass pastures. Ladino prolongs the pasture season since it permits pasturage somewhat earlier and later in the fall. During late July and throughout August it furnishes excellent pasture when bluegrass and other grasses offer little pasturage. Cattle, sheep, and hogs thrive on Ladino pasture, and it is one of the best forage crops for the poultry range. The quality of Ladino hay is excellent but yields are moderate. Applications of lime, phosphate, and complete fertilizer increase the yield.

Crimson clover, or incarnate clover, is a winter annual, usually sown in August or early September. It is important as a hay and green-manuring crop in the eastern Coastal Plains region, and the southern part of the Corn Belt and the northern Cotton Belt.

Crimson clover is usually planted at the rate of 20 pounds per acre, without a companion crop, and, if it is used for hay, it must be cut before the heads begin to turn brown, since the minute hairs on the stem and bloom of overmature hay may cause loss in feeding cattle. The fine hairs form balls of felt-like material in the intestines of animals and sometimes cause death.

This crop is of particular value to market gardeners. It fits into a short rotation and furnishes a large amount of ma-

terial for turning under for soil improvement. It is used also as a cover crop in orchards. When it is grown for this purpose its range is farther north than when it is utilized for hay. For orchard purposes, crimson clover is used as far north as the Ohio Fruit Belt on Lake Erie.



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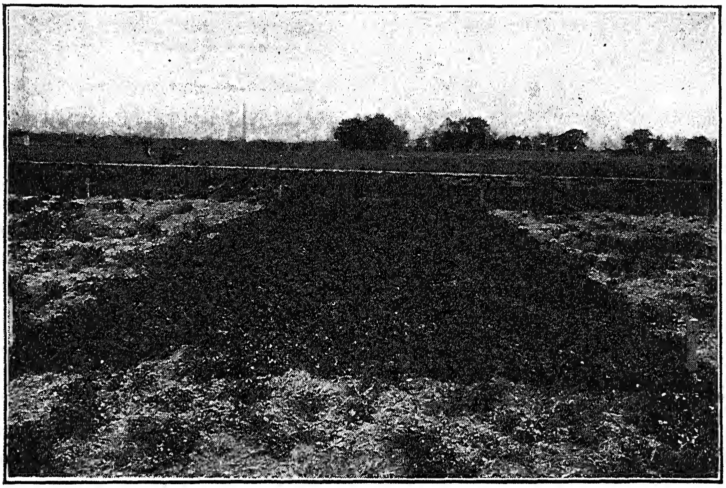
Crimson clover, a leading soil builder of the eastern Coastal Plains and northern Cotton Belt.

Operations in Growing Clover. The operations of importance in growing clover are:

1. Plant adapted seed of high purity and germination.
2. Apply lime on acid soils.
3. Use fertilizer where needed.
4. Plant at the proper rate and depth on a firm, well-surfaced seed bed.
5. Top-dress seedings and companion grain crops with manure or straw.
6. Cure clover hay in windrows or cocks.
7. Increase seed yields by cutting first crop in full bloom.
8. Produce clean seed by growing a clean crop.
9. Grow clover in a good rotation.

Plant Adapted Seed of High Purity and Germination. It is highly important that adapted seed of red clover be planted.

Not only must the plants survive through the winter but they must also withstand summer killing due largely to anthracnose and other clover diseases. Domestic American seed produced in the Corn Belt, the Northern States, or Canada from native stock has been found to be most dependable over the greater



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Domestic red clover (center plat) is better adapted to American conditions than crops from seed imported from Europe (right and left plats).

part of the clover-growing region. Red clover seed from Italy, once extensively imported, is wholly unadapted in the clover-growing areas of the United States. Seed from other European countries and from Chile yields much less than adapted domestic seed and is generally considered unadapted, particularly in red clover seed-producing areas where mixing and crossing with the hardier native varieties occur. Red clover seed from strains, long grown in Western Oregon and Washington, have been found to be less adapted for growing in the Corn Belt than domestic red clover from other states. Seed

from Corn Belt strains grown under certification in Oregon and the Northwest gives excellent results in the Corn Belt. Midland, adapted to the central and northern part of the Corn Belt, and Cumberland, adapted to the southern half of the Corn Belt and Southern States, are improved varieties recently developed by the United States Department of Agriculture and cooperating state experiment stations. Seed of Midland and Cumberland is grown chiefly in Oregon and Idaho for certification. In Tennessee, Virginia, Kentucky, and other southern clover-growing states, summer killing due to anthracnose and other diseases carried by leaf hoppers often causes great decreases in yields of clover, particularly of crops from European red clover seed. Attention is being given to the increase of seed of anthracnose-resistant strains of red clover especially adapted to these states.

The American and Canadian red clover plants are characterized by pubescent, or hairy, stems and leaves. The European varieties in general have smooth stems and leaves and lack hardihood. Native seed of known origin and adaptation should be secured.

Good clover seed not only should be of proper adaptation but should germinate well and be of high purity. In a good sample of seed, the individual seeds should be plump, of good color, bright, and lively in appearance. Seed of fresh appearance usually germinates well, but the seed should be tested in a seed germinator.

Clover seed as it comes from the field generally carries many weed seeds, such as the seeds of buckhorn, Canada thistle, night-flowering catchfly, dodder, dock, pigeon grass, and ragweed. Clover seed as produced on the farm usually carries too high a percentage of weed seeds to be planted without recleaning. The use of fanning mills and other seed-cleaning devices in the processing of clover seed after threshing reduces the percentage of weed seeds to the minimum. When clover seed is bought great care should be taken to ascertain if it is free of noxious weed seeds. The planting of cheap, weedy

clover seed has brought to many farms noxious weed pests such as bindweed, catchfly, and Canada thistle, which are costly to eradicate. Clover seed should be bought from dependable distributors who can guarantee its source of production and its adaptation and who distribute seed of satisfactory purity and germination, with due consideration of the performance of the clover crop in fields already planted.

Because of the extensive distribution of unadapted Italian and other European red clover throughout the clover regions in the United States in past years, this valuable crop has been given a great setback. American agriculture has suffered a loss of millions of dollars because of the carelessness of farmers in not assuring themselves of the source of origin and adaptation of their clover seed and because of the exploitation and frequent misrepresentation of those interested in the sale of unadapted red clover seed as a commercial commodity. The cooperative handling of red clover and alfalfa seed has been built up on a basis of supplying adapted seed whose high quality and purity of origin and quality are guaranteed by farmer-cooperative seed services. Many private seed companies have adopted the same program of service to the growers in the handling of red clover and alfalfa. There remain certain dealers, however, who continue to exploit cheap, weedy, unadapted clover and alfalfa seed which is often low in germination and is sold under a non-warranty clause. Dealings with such concerns should be avoided by farmers desiring dependable stands of clover and alfalfa.

Dr. E. A. Hollowell, Division of Forage Crops, United States Department of Agriculture, stated, in regard to the value of foreign red clover seed in an address before the International Crop Improvement Association and Western Seedmen's Association in December, 1936:

> The wide sale of foreign red clover seed will have a sinister effect on the red clover crop. After foreign seed is once planted it loses its identity. Seed from the surviving plants is indistinguishable from adapted seed and will become mixed and blended with it, in accord-

ance with the practices of the seed trade. The mixing and blending has a twofold effect on yields. First, the immediate effect brought about by the mechanical mixture of unadapted with adapted seed and, second, the polluting of the desirable plant characters of domestic red clover with inferior ones of foreign seed. This latter result occurs because the red clover plant is self sterile. That means that cross pollination between different plants is necessary before seed will form. Several kinds of bees, principally bumble and honey-bees, are chiefly responsible for cross pollination and in their quest for nectar and pollen thoroughly mix the bad with the good plant characters.

Thus lower yielding less adapted red clover is brought about and farmers become discouraged with failures to obtain crops. The demand for red clover seed decreases and the seed trade loses. The extra profit of today is lost in business of tomorrow. Red clover has too long been handled as a commodity with little concern as to what the seed may produce.

During recent years remarkable improvement has been made in increasing the quality of red clover seed. The term quality in seeds refers to germination, freedom from weed seed, and appearance such as color, plumpness, and luster. While high quality in red clover seed is important and should be constantly maintained, the parentage of the seed is the true basis of its value. Winter hardiness, insect and disease resistance, and desirable growth characteristics are not discernible by the "looks" of the seed. Those plant characters are expressed in the performance of the plant in the field and collectively are the basis of adapted seed. Farmers are beginning to realize the value of parentage in corn hybrids and soon will appreciate what is meant by adapted red clover.

Apply Lime on Acid Soils. Red clover is a lime-loving plant which will not thrive on acid soils. The majority of the soils of the North Central and East Central States are acid and need applications of lime for the successful growing of red clover. Soils should be tested to determine the degree of acidity and the amount of lime needed. Usually 1 to 3 tons of finely ground limestone or its equivalent in marl, hydrated lime, or other forms of agricultural lime is needed. Lime is generally applied when the seed bed is being fitted for corn

or other cultivated crops or in the fall after crops are harvested. Best results are secured by applying lime a year or more before red clover is planted in rotation.

Use Fertilizer where Needed. Commercial fertilizers are frequently of great value in the establishment of a good stand of red clover. Phosphorus in particular is needed by the clover crop, and most soils of the clover-growing region are deficient in it. As a general rule, 200 to 300 pounds of 16 per cent acid phosphate, or the equivalent in phosphate of higher analysis, give best results in the increasing growth of clover and the small-grain crops with which clover is usually seeded. On run-down and light soils, fertilizer containing potash as well as phosphorus, or complete fertilizers, such as 0–12–6, or a 2–12–4, are recommended. Top dressings of manure, 4 to 6 tons to the acre, increase the vigor of the clover crop, particularly when they are applied in association with lime and phosphorus. Manure and fertilizer may be applied when the seed bed of the grain crop with which clover is planted is being fitted or as a top dressing when clover is seeded in early spring on wheat or rye.

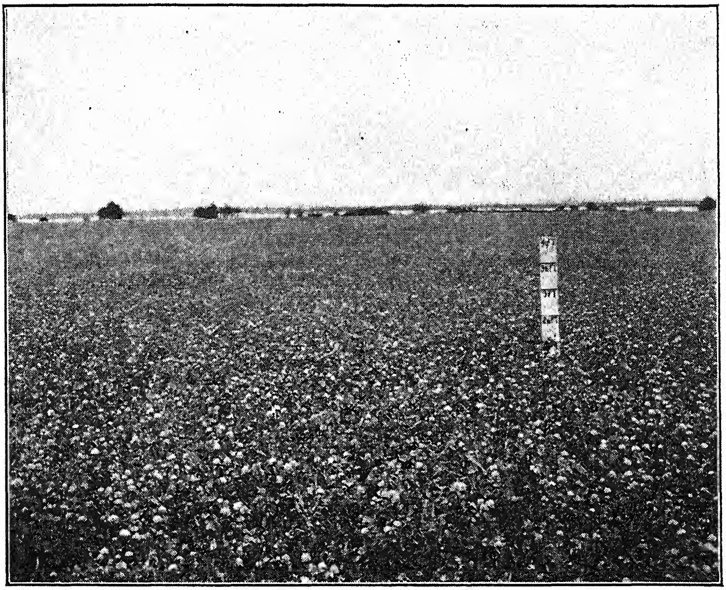
Plant at the Proper Rate and Depth in a Firm, Well-Surfaced Seed Bed. The best method of seeding clover depends upon the type of soil, its fertility, the supply of organic matter and lime, and the nurse crop. When clover is sown with a spring grain crop, and a drill with a seeder attachment is used, it is advisable to allow the delivery tubes of the seeder attachment to distribute the clover seed just in front of, into, or behind the disks. By this method the seed will be covered ½ to ¾ inch deep, or about half as deep as the small grain crop. If it is broadcast and harrowed in, most of the seed is covered to the proper depth, but more seed is needed to get a uniform stand.

The 4-inch-disk grass and clover seed drill is quite satisfactory for seeding on fall-sown grain crops. This drill is also satisfactory for summer seedings, if the seed bed is well firmed. On a loose seed bed, the seed is likely to be covered too deeply.

On the heavier types of soils, which become honeycombed through alternate freezing and thawing, early spring seedings are usually successful. On sandy soils, this method frequently fails to cover the seed well, and it is advisable to wait until the seed can be covered with the spike-tooth harrow.

Seeding Clovers. In major seed-producing areas clover is usually sown alone, 7 to 9 pounds or 3½ to 5 quarts per acre. The greater part of the clover seed is planted with mixtures of other grasses and legumes. Table 25 suggests the range in the amount of seed to sow for hay and pasture on different types of soil. A number of farmers are finding it profitable to include alfalfa and sweet clover in their pasture mixtures. From 3 to 5 pounds of either may well be added to the mixtures.

Top-Dress Seedings and Companion Grain Crops with Manure or Straw. Light top dressings of straw, or manure, ap-



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A field of red clover ready for cutting for hay.

TABLE 25

Grass and Clover Seed Mixtures for Hay and Pasture

For Hay and Permanent Pasture on Sandy Loams

	Pounds per Acre
Kentucky blue	4 – 6
Orchard grass	5 – 7
Timothy	3 – 5
Redtop	1 – 2
Red clover	3 – 5
Alsike	3 – 4
Alfalfa	2 – 4
White	½– 1
	21½–34

For Hay on Heavy Clay Loam or Clay

	Pounds per Acre
Red clover	6– 8
Alsike	4– 6
Timothy	3– 6
	13–20

For Hay on Well-Drained Loams, Clay Loams, and Silt Loams

	Pounds per Acre
Red clover	7– 9
Timothy	5– 9
	12–18

For Cut-Over Pasture

	Pounds per Acre
Red clover	3
Timothy	2
Alsike	2
Orchard grass	4
Redtop	2
White clover	1
	14

TABLE 25 (*Continued*)

Hay on Soils Verging on Acid Conditions

	Pounds per Acre
Red clover	6– 8
Alsike	4– 6
Timothy	3– 6
Redtop	2– 4
	15–24

For Hay and Permanent Pasture on Well-Drained Loam

	Pounds per Acre
Kentucky blue	4 – 6
Timothy	3 – 4
Red clover	4 – 5
Alsike	2 – 4
Alfalfa	2 – 4
White	½– 1
	15½–24

For Hay and Permanent Pasture on Poorly Drained Soil

	Pounds per Acre
Kentucky blue	4 – 6
Redtop	2 – 3
Canada blue	2 – 3
Timothy	1 – 3
Red clover	3 – 5
Alsike	3 – 5
Alfalfa	2 – 4
White	½– 1
	17½–30

plied in late fall, winter, or early spring on wheat or rye seeded with clover, greatly benefit the clover seeding as well as the grain crops. A manure spreader should be used to secure an even distribution. Late fall and early winter top dressings aid in the prevention of winter killing and heaving due to frost action. The effect of top dressing is therefore usually much

greater than can be attributed to the fertilizer value of the dressing. The top dressing of clover after the first season's growth is also effective.

Cure Clover Hay in Windrows or Cocks. Red, mammoth, and alsike clover may be cut for hay from the time of full bloom until not more than one-half of the heads have begun to turn brown. The yield per acre of hay, the percentage of protein, and the amount of leaf present are higher at full bloom than at any time afterward. At the full bloom stage, the plants contain more moisture, and consequently curing is more difficult than at a later stage. When the second crop of red clover is desired for seed, it is advisable to cut the first crop before heads turn brown in order to avoid insect enemies.

The primary consideration in the curing of clover hay is to keep the leaves. If it is cured in windrows and cocks, the leaves and stems lose moisture evenly, and an excessive loss of leaves in handling is avoided. If the sun is bright and the crop is left too long in the swath, the leaves dry rapidly, are easily lost in handling, and a stemmy, inferior hay results.

Increase Seed Yields by Cutting First Crop in Full Bloom. Usually, the second crop of red or June clover is taken for seed. Apparently higher seed yields are secured during summer seasons with less than average rainfall.

The seed yield of red clover is greatly increased if the first cutting for hay is taken in bloom before the heads begin to turn brown. Cutting the first crop, or pasturing it, as is sometimes done, kills large numbers of clover-seed midges. The second, or seed-crop, of clover matures earlier if the hay crop is removed early, and the seeds harden to the point at which the second brood of midges does comparatively little harm. The stage of maturity at which the first, or hay crop, is taken often determines the success or failure of the red clover seed-crop. Early cutting for hay almost invariably is followed by an increased yield of seed.

When to Cut Red Clover for Seed. Red clover should be cut for seed when the heads have turned brown and the seeds have

hardened and have begun to show violet tints. If the crop is allowed to get too ripe, so that the heads are black, loss from shattering and breaking off of heads occurs. As a general rule, seed yields of 1 to 2 bushels per acre can be expected when the brown heads, threshed out in the hand, show 12 or more seeds to the head. Yields of 4 to 6 bushels are not infrequent.

The clover seed-crop is usually cut with the mower, with windrowing or bunching attachments. It should then be made into small cocks and allowed to cure in the field for 1 to 2 weeks, or until thoroughly dry. The crop should be handled as little as possible until it is properly cured, to prevent the breaking off of heads. It is a mistaken idea that the seed-crop should be allowed to rot in the field before threshing. This method causes great loss of seed and deterioration of quality through discoloration and decrease in germination. A better quality of seed and larger yields can be secured if the seed-crop is placed under cover as soon as it is dry, or well-made stacks covered at the top with canvas or several feet of straw are built.

A red clover seed-crop is usually cut and bunched for curing in late August or September. Threshing is done with a clover huller after 1 or 2 weeks' curing, or from stack or barn at a later date.

Mammoth clover ranges from 1 to 3 weeks later in ripening than medium red or June; hence the first crop of the second year of mammoth is taken for seed. As a general rule, larger seed yields are secured than from red clover. Good mammoth seed is in great demand. There is a great variation in the maturity and in the vegetative growth of mammoth clovers, as some strains are later and much larger than others. Farmers who grow mammoth clover for seed should secure their seed from the larger-growing, later-maturing strains. The seed of mammoth clover and that of red clover are apparently identical in appearance.

Producing Alsike Seed. Alsike gives an unusually reliable seed yield under northern conditions. The first crop is taken

for seed, and yields of 3 to 6 bushels are expected from good fields. Cutting begins the second year and is often continued through the third and fourth and sometimes the fifth year.

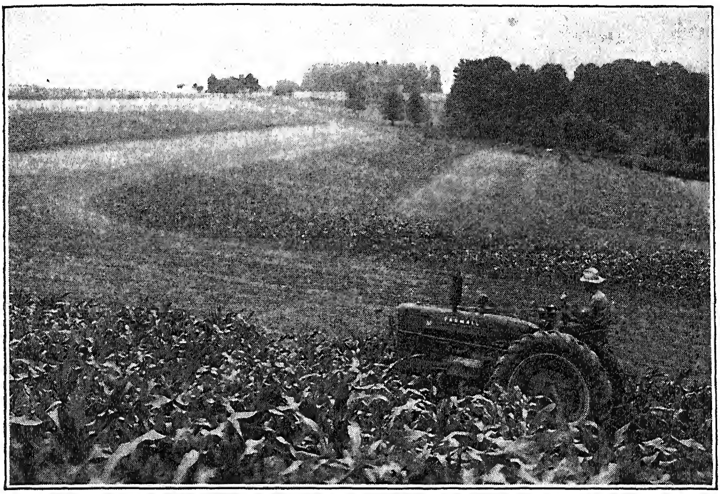
The alsike seed-crop is cut when the heads are brown. Usually, a mower with a windrowing or bunching attachment is used. The crop is cured in small cocks in the field for several days or a week. When thoroughly dry it may be threshed from the field. A safer practice is to store the crop in the barn or in well-made stacks protected by a canvas or several feet of straw over the top until threshing time. The older the fields are, the weedier they become; hence the best practice is not to allow alsike fields to stand longer than 3 years.

The leading weed mixtures in alsike are night-flowering catchfly (commonly called sticky cockle), white campion, Canada thistle, peppergrass, sorrel, and dock. Timothy becomes a bad mixture in old stands.

Alsike should be planted on clean ground, and the weeds should be pulled by hand or mowed to keep the stand clean. It is often practical to clean up the average field by hand, pulling or rogueing weeds such as catchfly, cockle, and dock, several days or a week before harvesting the seed. The weeds should be removed and burned.

Produce Clean Seed by Growing a Clean Crop. Only fields that are fairly free from weeds will produce a high grade of seed. Buckhorn, Rugel's plantain, sorrel, dock, and Canada thistle are common weeds in red clover and mammoth clover fields; these weeds, sticky cockle, and peppergrass, are common in alsike. It pays well to pull or hoe out the dock and thistles in fields that are not too badly infested. When the seed-crop is harvested, weedy areas should be cut and raked for hay so that the entire crop will not be contaminated. Although it is true that modern seed-cleaning machinery will take out a large quantity of weed seeds, it is nevertheless a costly process. Growers will get larger yields from clean fields and a higher price for their crops, and a much better quality of seed can be furnished the trade.

Grow Clover in Rotation. Red, mammoth, and alsike clover are well adapted to the common rotations of the Corn Belt and the Northern States, since they are usually seeded with the small-grain crops. The clover is secured without extra cost, except the seed and harvest cost, and receives the benefit



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Sound rotations and contour strip farming increase farm yields and profits.

of the fertilizer or top dressing of manure or straw applied to the small-grain crop.

A good clover sod, plowed in the fall or early spring, is recognized as an excellent foundation for large yields per acre of corn, beans, beets, or potatoes. By the proper use of clovers in rotation, the yield of successive crops in the rotation is favorably affected. On soils deficient in organic matter, clover should be included in rotation at least every third year. Turning under the crop, or partially pasturing and plowing under, increases the effectiveness of clover by the addition of nitrogen and organic matter. On highly fertile soils, rotations which

include clover every fourth year are frequently practiced. On farms where the maintenance of organic matter is highly important, mammoth clover is often preferred; the seed is harvested, and the stubble, straw, and roots turned under, or the entire crop plowed under.

On average soils, it is impossible to maintain a profitable cropping system, over a series of years, without the inclusion of clover or alfalfa, sweet clover, or other legumes, with sufficient frequency to maintain organic matter and nitrogen and to control the common diseases and insect pests of the ordinary cultivated crops and small grains.

The following are typical clover rotations:

1. Three-year rotation
   - 1st year—red clover or mammoth clover
   - 2d year—corn
   - 3d year—oats, barley, wheat, or rye seeded to clover
2. Four-year rotation
   - 1st year—clover
   - 2d year—oats
   - 3d year—corn
   - 4th year—wheat seeded to clover
3. Four-year rotation including beans and beets (on very fertile soils)
   - 1st year—clover
   - 2d year—corn, beans, or beets
   - 3d year—beans, beets, or corn
   - 4th year—oats or barley seeded
4. Five-year rotation including timothy, red, and alsike clover meadow
   - 1st year—alsike clover and timothy meadow
   - 2d year—corn
   - 3d year—oats seeded to red and alsike clover and timothy
   - 4th year—clover and timothy
   - 5th year—timothy and clover
5. Six-year rotation including beans, beets, potatoes with clover every third year (for soil having average fertility)
   - 1st year—clover, red and alsike, or red clover alone

2d year—corn or beets
3d year—oats with clover
4th year—clover
5th year—beans, potatoes, or corn
6th year—wheat or rye with clover

6. Alsike seeded in rotation
   1st year—alsike
   2d year—corn
   3d year—oats or barley seeded to alsike
   4th year—alsike

Rotation 5 is particularly desirable where sugar beets, potatoes, and beans are important crops. It provides for the growing of these crops once in 6 years and supplies a crop of clover every third year.

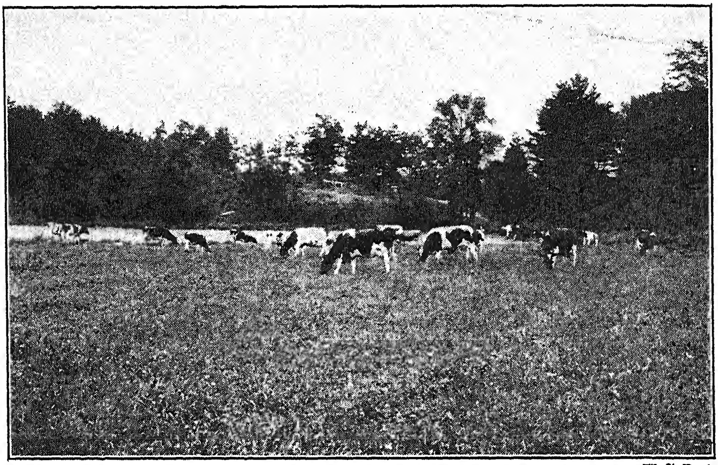
The occurrence of black scurf and leaf spot of sugar beets, scab and black scurf of potatoes, and anthracnose and blight of beans is greatly reduced by a rotation which includes these crops only once in 6 years. The loss from insects is also reduced to the minimum. Plowing is needed only every third year.

When Clover Fails. When clover fails in communities where it once succeeded, agriculture is on the down grade, run-down farms are numerous, less livestock is fed, crop yields are lower, and farms change hands rapidly. In regions where clover and alfalfa thrive, farmers are generally prosperous, crop yields are high, dairying and livestock raising are successful, farm ownership is more stable, and land values are higher. Almost invariably, individual farmers who have good success with clover or alfalfa in their rotations are rated as prosperous farmers, whereas those who fail to get clover or alfalfa usually have increasing difficulty in making their farms pay. The rapid decrease in red clover acreage is a matter for serious consideration.

Farmers who are unable to get successful stands of clover will do well to find out the causes and make conditions right for the success of this valuable crop, rather than continue

without the aid of clovers in rotation. Success with the clovers and also with alfalfa and sweet clover is fundamental to the success of crops following in rotation.

Why Do Clovers Fail? The two great causes of clover failures during the past few years are the extensive planting of unadapted seed and adverse soil conditions, such as soil acidity, lack of organic matter in the soil, depleted fertility, and drought.



U.S.D.A.

The second growth of timothy and clover after the harvest of a hay crop furnishes excellent pasturage in late summer and fall.

Plant Adapted, Native-Grown Seed, of High Purity and Germination, and Lime Acid Soils. Large quantities of unadapted red clover seed frequently imported from Europe and South America cause great losses to American clover growers. Native clover adapted to the mild climatic conditions of western Oregon is often unadapted in eastern clover-growing regions. Midland clover and Cumberland clover grown under inspection for not more than three generations in the Northwestern States are well adapted to clover-growing areas in the eastern

half of the United States, Midland in the northern half and Cumberland in the southern half of the eastern clover area. The requirements of the 1937 Agricultural Conservation Program that adapted red clover seed be planted, and that sound practices be employed by cooperators, prevented great losses to American farmers. The Italian seed has been shown to be worthless under American conditions, and the seed from other European regions inferior and generally unadapted.

Good seed will not, however, succeed on soil in poor condition. Soil acidity, or lack of sufficient lime in the soil, is responsible for a large number of failures. Although all clovers are not equally sensitive to soil acidity, they all make a more thrifty growth on soils supplied with lime than on acid soils.

It is natural for cropped lands, in a humid section, gradually to give up their lime and become acid. Sand and sandy loams are likely to become acid sooner than clays and clay loams.

Under the Federal Seed Act of April 25, 1926, Italian red clover seed is stained with a red stain to the extent of 10 per cent of volume at port of entry. The act requires that imported clover seed from Europe and other countries, except Canada, be stained 1 per cent green. Canadian red clover seed generally well adapted in the United States is stained 1 per cent purple.

SUGGESTIONS

1. Farmers who succeed in getting good stands of clover almost invariably are successful crop growers and livestock feeders.

2. What is the red clover acreage of your township, county, and state? What were the acreages ten years ago? Twenty years ago? Is clover increasing or decreasing? Why?

3. What were the highest yields of red clover hay in your locality during the past season? Who grew them? What is the average yield of clover hay per acre in the township? In the county? How many farmers do you know who failed to get successful seedings of red clover or mammoth? Why?

4. Where did the growers of the highest yields get their seed? When

and how do they plant red clover? Do they use manure? Do they use commercial fertilizer? What kind?

5. To what extent is alsike clover planted in your neighborhood? Which does the best on poorly drained land, alsike or red clover? Is clover planted alone or with timothy? What is the usual yield of clover seed per acre in your township? How much is grown?

6. What weeds are found in clover seed produced in your locality? Can they be cleaned out of the seed? How?

7. Secure samples of clover seed used locally for seed. Do you know positively where grown? Spread on white paper and make weed count. Identify weed seeds. Test germination. Judge fitness of each for planting.

8. Spade up roots of clovers. Carefully work free of soil. Note nodules. Explain function.

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CHAPTER XXV

ALFALFA AND SWEET CLOVER GROWING

Alfalfa provides the largest yields of highest quality forage, enriches the land, and reduces production costs of both crop and livestock products. Prosperity follows alfalfa. R. A. MOORE

In the development of agriculture in our Western States, alfalfa has long been the most important leguminous forage crop. Brought to California by the Forty-Niners and to Utah by returning Mormon missionaries, alfalfa has a history closely associated with the romance and the glamour of the development of the agriculture and civilization of our Western States. An equally remarkable record is now being made by this wonderful crop in the expansion of acreage in the Corn Belt and the Northern States of the eastern half of the United States. In 1936 Michigan became the leading alfalfa-growing state in the union, with an acreage of one million one hundred and twenty thousand acres. In the Federal Agricultural Adjustment Program, which began in 1933, the growing of alfalfa was strongly encouraged in the effort to balance our agricultural production and to conserve soil fertility.

The inclusion of alfalfa in the planned rotation system of a farm generally has a far-reaching and highly desirable effect on many phases of farm enterprise. It brings about marked improvement in soil fertility. Alfalfa is a leading legume in adding nitrogen and humus to the soil and is a most efficient crop in preventing soil erosion. Crops of corn, potatoes, and small grains following alfalfa in rotation give much greater yields per acre at much less cost per bushel. Growing a substantial acreage of alfalfa in rotation provides for the main-

tenance of more livestock on the farm. The cost of feed bills for dairy cattle, beef cattle, sheep, hogs, and poultry is greatly reduced by the home production of alfalfa hay and pasture. When alfalfa is fed in properly balanced rations, including corn and grain feeds generally produced on the farm, livestock thrives at reduced cost.

Michigan Exp. Sta.

Alfalfa furnishes three or four cuttings of hay during favorable seasons in the Corn Belt and in the South.

Recent scientific studies indicate that the vitamin content and the mineral salts found in milk and other animal products vary in accordance with the ration fed to livestock. Alfalfa hay and pasture is exceedingly high in protein, vitamins, calcium, magnesium, and other minerals. As the acreage of alfalfa increases, beneficial effects result not only to livestock but also to humanity.

In the humid eastern half of the United States, most soils are deficient in lime and phosphorus. To grow alfalfa successfully on such soils applications must be made of lime and of acid phosphate or other fertilizers including phosphorus. Potash is also needed on many soils, particularly in the New England States. These practices benefit following crops in the rotation and increase the efficiency of the farm in producing meat and milk. The mastery of alfalfa and the proper inclusion of this crop in farm rotations often accomplish a great improve-

ment in farm management in many phases, as the crop greatly increases the profits of the producer and improves and conserves the soil.

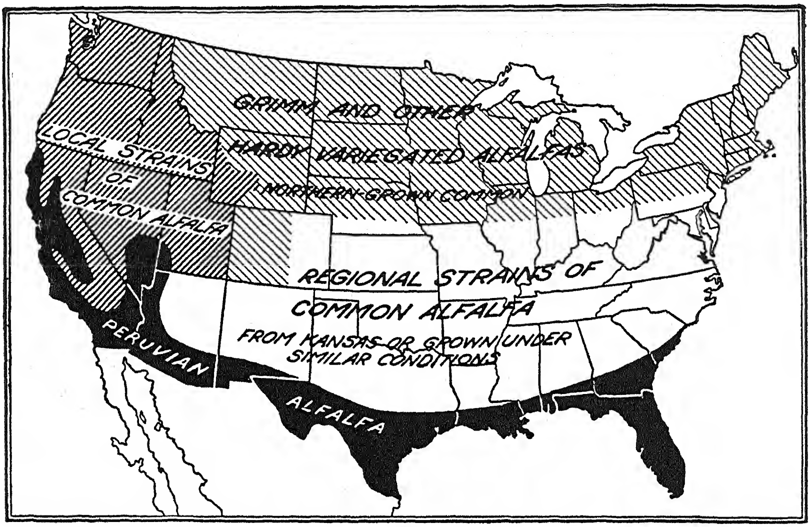
The Rules for the Growing of Alfalfa Are:

1. Secure adapted seed from dependable sources.
2. Plant alfalfa on well-drained soils.
3. Apply ground limestone, marl, or other form of lime where needed.
4. Prepare a firmly compacted, well-surfaced seed bed, or seed with small grain crop.
5. Plant at right time, rate, and depth.
6. Fertilize with acid phosphate and manure where needed.
7. Inoculate where alfalfa or sweet clover has not been grown previously.
8. Cut alfalfa for hay at best stage of growth.
9. Cure in windrows or cocks to retain leaves.
10. Pasture well-established fields judiciously.
11. Harvest for seed when pods are brown.

Secure Adapted Seed from Dependable Sources. The increased frequency of successes with alfalfa over an extensive area is largely due to the rapid increase in production of American-grown seed of hardy varieties. Numerous failures are due to the planting of unadapted seed. A total exceeding fifteen million pounds of alfalfa seed was until recently imported annually into the United States from South America, the Mediterranean regions, Arabia, and Africa. This seed, produced in regions of mild climate, is exceedingly susceptible to winter-killing and, in summer, to injury from disease, when grown in the Corn Belt and the Northern States of the United States and in Canada. Native alfalfa seed from southern California, Arizona, New Mexico, and Texas produces unprofitable crops in the Corn Belt and the northern regions.

Dependable seed of hardy common alfalfa and of Grimm, Cossack, Hardigan, Ranger, Buffalo, Ladak, and other hardy strains is being extensively grown in Utah, Idaho, Montana,

the Dakotas, Minnesota, Nebraska, Kansas, and to an increasing extent in Missouri, Iowa, Illinois, Indiana, Wisconsin, Michigan, and Ontario. In the drought year of 1936 Michigan led all other states in alfalfa-seed production. This seed, planted according to its adaptation, gives remarkably uniform



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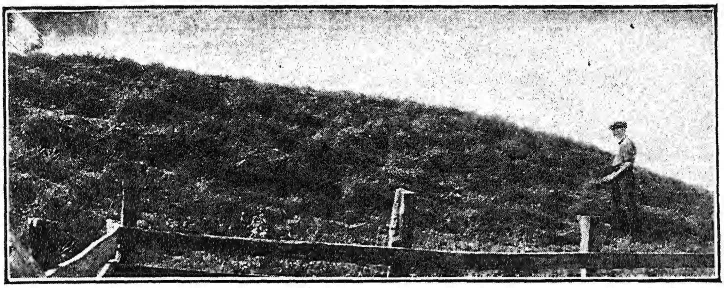
Map showing adaptation of alfalfa varieties. The origin and adaptation of alfalfa seed must be known by the grower. Seed from the Southwest and South winter-kills in the Corn Belt and North.

results. Unfortunately, it is very difficult to tell adapted, native-grown seed from unadapted, southern-grown, and imported seed on the market. Hence it is highly important that alfalfa seed be purchased from dependable sources. During World War II and the year following Argentine alfalfa seed was imported to the extent of nearly three times the amount of former years and widely distributed in the Corn Belt and the Northern States. The northern half of the United States which produces only 30 per cent of the alfalfa seed needed consumed

60 per cent of the domestic crop of the United States. More than half of the alfalfa seed planted in the important alfalfa-growing area of the northern half of the United States was unadapted seed from the Southwest and the Argentine, and widespread failures resulted. Farmers cannot be too careful in choosing the sources from which they secure adapted alfalfa seed.



Courtesy of The Seed World, Chicago

Wendelyn Grimm's original alfalfa field as it appeared in 1922, sixty-five years after planting near Excelsior, Minn. This hardy variety has extended alfalfa growing to many northern states.

Alfalfa seed in sealed bags, certified for variety and origin, is now being grown by cooperative seed producers' associations in Idaho, the Dakotas, Utah, and other northwestern states. Farmers' cooperative seed-distributing organizations in the Corn Belt, the Northern States, and the Southeastern States are distributing this seed and alfalfa seed purchased in the Northwest, the northern Corn Belt, and Canadian producing areas. Dependable seed companies are following similar methods in the handling of alfalfa seed. It is therefore possible for the well-informed alfalfa grower to secure dependable, adapted seed of known origin at reasonable prices. Such seed, however, cannot be bought as cheaply as the unreliable imported seed stained orange red or red to the extent of 10 per cent and unstained southern-grown domestic alfalfa seed. Cheap seed of

unknown origin usually proves to be highly expensive when planted in regions where seed of hardy varieties is required.

Choose the Right Variety. New varieties of alfalfa developed by the United States Department of Agriculture in cooperation with state experiment stations in alfalfa seed-producing states are of greatest value to alfalfa growers because of their yielding ability, superior adaptation, and resistance to alfalfa wilt and other diseases. The Ranger from the Nebraska Station is wilt-resistant and is particularly adapted to Nebraska conditions and the northern part of the Corn Belt and the North Eastern States. The Buffalo, a wilt-resistant variety from the Kansas Experiment Station, is considered best adapted to Kansas conditions and the southern half of the Corn Belt. The Nemestan has been found to be resistant to nematodes and somewhat resistant to wilt at the Utah and Nebraska experiment stations. Work of great promise is being done at the Kansas Experiment Station with true hybrid alfalfas that correspond to hybrid corn varieties in increased yield and vigor.

Common alfalfa is the most extensively grown variety. It is characterized by flowers of blue and purple shades, high crowns, and a large percentage of straight tap roots. Common alfalfa is extensively grown for hay and seed in Utah, Colorado, Kansas, Nebraska, the Dakotas, and Montana. For hay purposes, common alfalfa seed produced in these regions is adapted for profitable alfalfa growing throughout the Corn Belt and the southern sections of northern states.

Grimm alfalfa is an unusually hardy variety, best adapted to the northern part of the Corn Belt, the Northern States, and the Canadian provinces. It is a variegated variety characterized by blossoms of many shades, including yellow, white, blue, purple, and numerous blends of these colors. Its crown is more branched than that of the common variety and is seated closer to the surface of the soil, frequently branching below the surface. A much higher percentage of the roots of Grimm are branched. This feature apparently accounts in part for the

hardihood of Grimm alfalfa and its resistance to heaving during the winter and spring when planted in northern regions.

Grimm alfalfa was brought to the United States by a German immigrant to this country—Wendelyn Grimm—who planted it near Excelsior, Minnesota, in 1858. Mr. Grimm grew this alfalfa for a number of years and attracted the attention of his neighbors by his successful livestock-feeding operations during periods of drought, when others, planting ordinary forage crops, were unable to grow sufficient feed. The Grimm alfalfa spread slowly, locally, until it was carried west into the Dakotas and Idaho, chiefly through the activity of Mr. A. B. Lyman, who brought about its extensive commercial production. In recent years, Grimm Growers' Associations have sprung up in Idaho, Montana, Utah, and the Dakotas for the extensive production of Grimm seed.

The Grimm Growers' Associations and crop improvement associations producing certified seed cooperate with their state agricultural colleges and departments of agriculture in maintaining systems of field and threshed seed inspection which protect the varietal purity and seed purity of alfalfa seed produced by members. Such seed is sold as Certified Grimm or Certified Hardigan, and so on.

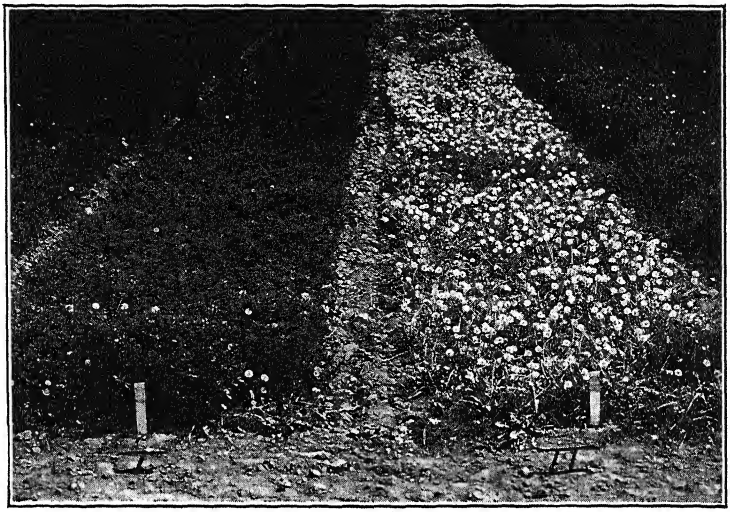
The Ladak alfalfa secured in Tibet by a plant explorer of the United States Department of Agriculture, the late Mr. H. L. Westover, is proving to be particularly hardy in dry, cold regions of the West and the Northwest.

Cossack alfalfa is a hardy variety introduced into the United States by Professor N. E. Hanson of the South Dakota Experiment Station. Professor Hanson secured the Cossack in Siberia while he was engaged in making a survey of plants of that region adapted to his state. The Cossack is a variegated alfalfa showing the same blossom colors as Grimm, with a higher percentage of yellow and white. It is well adapted to regions of vigorous winter climate.

Occasionally, favorable years for seed production occur in eastern regions and native grown seed is available. The On-

tario Variegated and Michigan Lebeau are produced in excess of local demands in certain years. These strains are highly esteemed in the Northeastern and the North Central States.

The Hardigan (Hardy Michigan) is a selection from the Baltic, made by Professor F. A. Spragg of the Michigan Ex-



Michigan Exp. Sta.

Southwestern alfalfa seed is unadapted for use in Northern States and the Corn Belt. Plat I, Hardigan alfalfa. Plat II, Hairy Peruvian from Arizona, mostly dandelions with little alfalfa after first winter.

periment Station. It develops blossoms profusely and sets seed with a comparatively high degree of certainty under humid conditions. This variety leads in forage tests at the Michigan Station, but its great advantage is in its ability to produce seed under eastern conditions. This variety is being grown extensively in Michigan for local seed production.

The Baltic is apparently of uncertain origin, taking its name from Baltic, South Dakota. It is very similar to Grimm in all its characteristics.

Orrenberg alfalfa is a very hardy, yellow-flowered variety with a decumbent habit of growth. It produces smaller yields of hay, but is advocated as a pasture variety because of its tendency to produce branch roots with additional crown development. Although it is adapted to the northern range of alfalfa-growing regions, its production is limited in the United States by the difficulty of harvesting seed on a profitable scale. The seed of Orrenberg is borne in sickle-shaped pods, each of which carries a single seed. This seed ripens unevenly and shatters easily, and hence seed production is difficult

Alfalfa varieties are classified as follows:

Medicago Sativa. This variety is characterized by blue and purple blossoms, upright stems, high crowns, and a preponderance of straight tap roots. Common alfalfa represents this species.

Medicago Falcata. This group has yellow flowers, a decumbent habit of growth, low-set, branched crowns, and a preponderance of branched roots. Varieties of this species are extremely hardy. Orrenberg is a typical example.

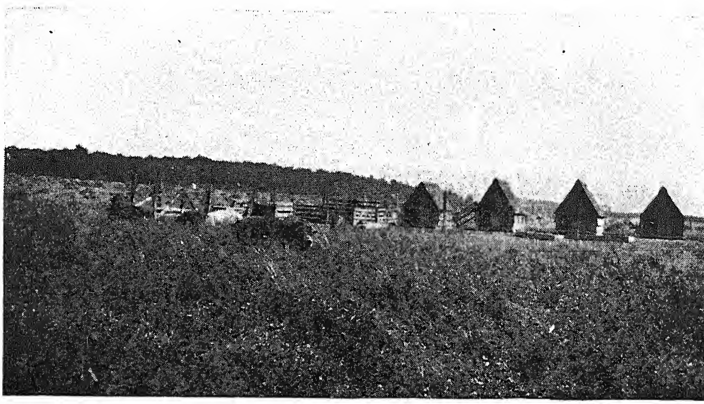
Variegated Alfalfas. These are hybrids of *M. falcata* and *M. sativa.* The blossoms range in color from light shades of blue to purple, with frequent white and yellow blooms and blends of the colors mentioned. The variegated alfalfas are hardier than the common blue-flowered variety. The Grimm and Cossack are typical variegated alfalfas.

Plant Alfalfa on Well-Drained Soils. Alfalfa is adapted to a wide range of soil conditions. It is grown successfully on clays, loams, sandy soil, and even on muck soils if sufficiently well drained. Adequate drainage is a requirement of the crop, owing to its depth of root growth and susceptibility to heaving and winter-killing on poorly drained soils.

Apply Ground Limestone, Marl, or Other Form of Lime where Needed. Lime is essential to successful alfalfa growing on acid soils. If clovers and other legumes do not thrive, the acidity of the soil should be tested. Usually 2 tons of ground limestone, 1½ tons of hydrated lime, or several cubic

yards of marl are needed per acre. (See discussion of liming the soil, Chapter VII.)

Prepare a Firmly Compacted, Well-Surfaced Seed Bed, or Seed with Small Grain. Alfalfa seed starts best on a firm seed bed. Cultivated crops such as corn, beans, potatoes, or beets usually leave the land in a clean condition readily shaped for alfalfa.



Michigan Exp. Sta.

Alfalfa furnishes excellent pasturage for hogs and other livestock.

If the land is not sufficiently free from weeds and grass, fall or early spring plowing is necessary; and frequent use of the disk or spring-tooth or spike-tooth harrow, at intervals of a week or ten days until weeds and grasses are conquered, is advisable. If the ground is clean, thorough disking is sufficient. Just before seeding, the land should be rolled with cultipacker or roller so that it will compact firmly. On soils which are deficient in organic matter, applications of well-rotted manure in sufficient amounts should be made, o" the content of humus should be increased by the turning under of clover, vetch and rye, sweet clover, or other green-manuring crops.

Plant at the Right Time, Rate, and Deoth. Although the best and most persistent stands of alfalfa are secured by seed-

ing alone, without a companion crop, on cultivated lands free from weeds and grass, it has been demonstrated in numerous instances that on soils of average fertility, if well drained, successful stands of alfalfa may be secured by seeding in the spring with barley, oats, buckwheat, or on winter wheat, or rye.

A better growth of alfalfa will be secured by using only 1 bushel, or less, of barley or oats per acre, or 1 peck of buckwheat.

A light seeding of grains made with early spring planting may be preferable, however, to the weed growth which is likely to occur on seed beds not thoroughly clean.

Best results can often be secured, though at somewhat greater expense, if the seed bed is worked thoroughly until late May or early June and planted without a companion crop. If ground is very weedy or grassy, it may be advisable to continue disking and harrowing until late June or mid-July and to seed only when the seed bed is fairly free of weeds and grass. Since alfalfa will occupy the land for 4 to 6 years or more, greater expense and time is warranted in preparation for alfalfa than for annual crops.

Early spring seedings after cultivated crops, either with or without companion crops, have the advantage of an assured supply of moisture for early growth. Seedings made in summer give ample time for thorough preparation of the seed bed.

Seed should be planted at a depth of ½ to ¾ inch. Seed should be allowed to fall ahead of, into, or behind drills of grain drill but not through the drills. If a special alfalfa drill is used, seed must not be planted too deep. Seed planted at a depth of 2 inches seldom is able to send a sprout to the surface. If seed is broadcast, it should be covered with a harrow or a brush harrow.

Of Grimm seed, 10 or 12 pounds are ample. Many farmers get excellent results with 8 pounds per acre.

Of common alfalfa seed, 12 to 20 pounds are usually planted, 15 pounds being the average.

Fertilize with Acid Phosphate and Manure where Necessary. Alfalfa responds to applications of 200 to 300 pounds of acid phosphate, made either at the time of seeding or as a top dressing. On soils deficient in fertility 250 to 300 pounds of a complete fertilizer such as 4–14–6 or 3–16–8, applied when fitting the seed bed or when planting, give excellent results.

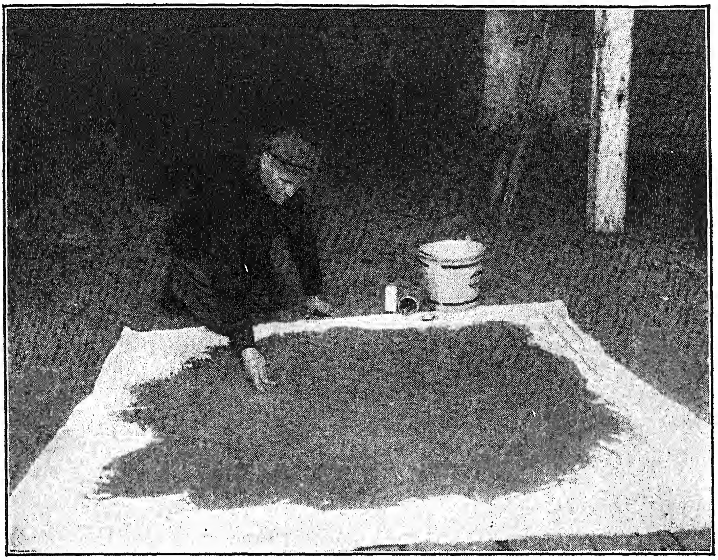
Well-rotted manure applied when the seed bed is fitted is particularly effective in the securing of a stand of alfalfa on light or droughty soils.

Inoculate where Alfalfa or Sweet Clover Has Not Been Grown Previously. Inoculation is necessary on soils where successful stands of alfalfa or sweet clover have not been grown previously. If plants of thrifty, well-established alfalfa are carefully dug up and the roots gently washed free of soil, small nodules will be found singly or in clusters on the roots. These nodules are the homes of countless nitrogen-gathering bacteria, and through their aid the alfalfa plant is able to make use of atmospheric nitrogen. The bacteria found on alfalfa and sweet clover are similar and are interchangeable, but those found on clovers and other legumes are not suitable for inoculating alfalfa. On soil rich in nitrogen alfalfa may make a fairly successful growth without inoculation, feeding on soil nitrogen, but for greatest success and in order to benefit the soil thorough inoculation is necessary.

The most convenient way of insuring the presence of these bacteria, in soils from which they are probably absent, is the culture method. Cultures are prepared by commercial firms and some experiment stations and distributed in small bottles, or in packages of humus. Fresh culture should be secured. The culture is applied to the seed, and planting is made immediately.

Another method, possibly more effective though not so convenient, is the soil-inoculation method. Soil is taken from a field of thrifty, well-inoculated alfalfa or sweet clover from a

layer just beneath the surface to a depth of 4 inches. It is best to shovel aside about 1 inch of surface and take soil to a depth of 4 inches. This soil should not be exposed to sunlight and, if it is somewhat wet, it may be put in condition by



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Alfalfa and sweet clover seed should be inoculated with bacterial culture or inoculated soil before planting on soil that has not previously grown these crops successfully.

spreading out to dry in a cellar, on a barn floor, or in a shaded room where sunlight will not injure the bacteria. When in condition, this soil should be spread broadcast or applied through fertilizer attachment on drill in the evening, or on a rainy or dark day; the harrow should be used immediately afterward to cover the newly applied soil, unless there is a gentle rain; or the soil may be applied at time of seeding through the fertilizer attachment. If applied through fertilizer attachment, several hundred pounds per acre of inocu-

lated soil is sufficient. To secure even distribution by broadcasting, a wagon load or more is needed.

Once a field is successfully inoculated, inoculation will remain for many years provided soil conditions remain favorable. However, it is advisable to inoculate the seed or soil if the soil has not grown alfalfa successfully, or not for a long period.

Cut Alfalfa for Hay at Best Stage of Growth. Alfalfa should be cut for hay when the flowers are in quarter to full bloom. Three cuttings per year are usual in the Corn Belt, but there is a tendency toward two cuttings, both made at the three-quarters to full-bloom stage in the Northern States. A somewhat more palatable hay is secured if alfalfa is cut in quarter bloom, but larger yields over a period of years and more enduring stands are secured if it is cut at the three-quarters to full-bloom stage. Recent Wisconsin and Kansas experiments bear out this point. The old sign, "when shoots at base are ½ to 1 inch long," is fairly reliable, but occasionally the shoots start before the bloom is well developed.

Effect of Number of Cuttings on Yield. Ohio experiments show that three cuttings of alfalfa at Columbus give larger yields than two cuttings. Since most of western and southern Ohio has a growing season as long as or longer than Columbus, these results should apply in all parts of the state except northeastern Ohio. Experiments at Wooster by L. E. Thatcher indicate that two cuttings are probably preferable to three. But when three cuttings yield an average of 8410 pounds of hay, whereas two make only 5730 pounds of inferior hay, as at Columbus, there is little doubt of the superiority of three cuttings. (C. J. Willard.)

Cure in Windrows or Cocks to Retain Leaves, Color, and Palatability. The leaves are the most valuable part of the alfalfa plant, almost equal to bran, pound for pound, in feeding. The method used in curing alfalfa should be one that will conserve the leaves.

Legume hay crops, such as alfalfa, clover, sweet clover, and soybeans, cure best under conditions that prevent the too rapid drying of the leaves and stems. Transpiration is thus allowed to continue, and stems and leaves cure uniformly with the minimum of leaf loss. These crops are generally raked

Alfalfa—Cox and Megee

The left-hand side-delivery rake works against the tops of the newly cut swaths, rolling the swath into a loose windrow with the majority of the leafy tops toward the center.

into windrows before the leaves have dried in the swath, and either they are allowed to cure in the windrows during most favorable weather or the windrows are thrown into small cocks if the weather is threatening or unfavorable. In the windrow or cock, the majority of leaf surfaces are protected from the sun, and they continue to exude moisture by transpiration. The general practice is to cut the hay in the morning, allow it to wilt in the swath for several hours, then rake it into windrows with side-delivery rake, and allow it to remain in the windrow for one or two days, or in cocks for the same period or longer if rainy weather develops. In the event

of heavy rain, the cocks must be opened up and dried when drying weather again occurs and recocked when in the right condition.

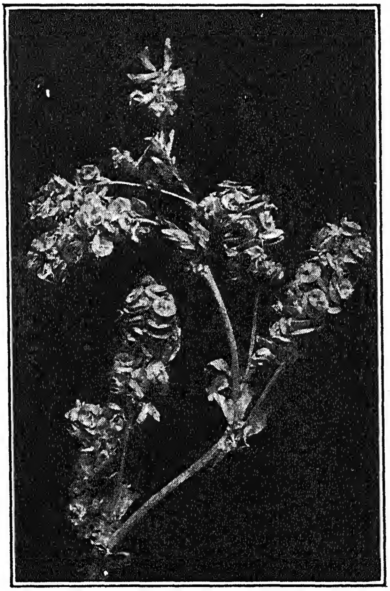
In the handling of alfalfa, clover, sweet clover, and soybeans for hay, a system known as the Dain system is particularly effective. In this system a left-hand side-delivery rake is used. This rake is not cylindrical, but tapers, the small end being at the right. By using the left-hand rake, the crop is picked up as laid down by the mower and rolled into a loose windrow with approximately four-fifths of the stems out. The crop is raked as soon as cut, and it cures in the windrow in one or two days. If it is rained upon, the windrow is turned over to dry by use of the left-hand side-delivery rake.

Store in Stacks or Mow, or Bale for Market. Alfalfa, clover, sweet clover, and soybean hay is considered right for the stack or barn when it is so dry that no moisture shows when the stems are twisted in the hands. If it is put in the barn or stack when too moist, heat may result, with possible damage to the hay and loss of barn by fire due to spontaneous combustion. Barn-stored hay is usually of the best color and quality. Stacks should be well built and properly capped in order to shed as much rain as possible and to prevent loss due to blowing away. Salting of hay in the mow or stack is often considered to add to its palatability and also to influence its quality. One or two pounds of salt is used for a ton of hay as it is put in the mow.

Harvest for Seed when Pods Are Brown. Alfalfa should be cut for seed when three-fourths of the pods are brown. The second cutting is usually taken for seed. In dry summers seed will often set well in the East Central States, and excellent local supplies from alfalfa of known adaptation can be secured. Yields of 2 to 5 bushels result under such conditions. Usually when 6 or 7 out of 10 blooms show a swelling at the base, indicating seed formation, a seed-crop worthy of harvest is developing.

Increased yields of seed are being secured by applying DDT as a 5 per cent DDT dust or a 3 per cent spray to prevent losses from insects such as the mirids and leaf hoppers in general.

The seed-crop is cut with a mower and cured in small cocks in the field. It is threshed with a clover huller equipped with alfalfa screens.



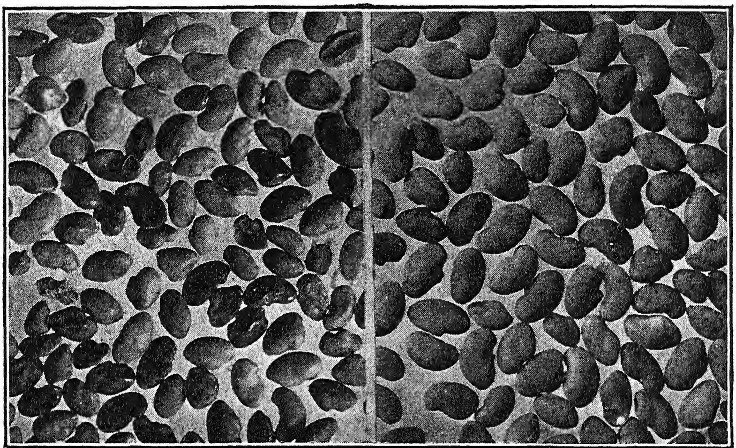
Alfalfa in the burr. The seed crop is ready for harvest when three-fourths or more of the pods are brown.

Idaho, Montana, the Dakotas, Utah, Kansas, Nebraska, Michigan, Minnesota, and Wisconsin lead in the production of seed adapted to the Northern States and the Corn Belt.

Additional Information

Alfalfa is one of the most ancient forage crops grown by man. From the time of their earliest recorded history, the

Persians knew the value of alfalfa. The army of Xerxes carried it into Greece in 480 B.C. During the years which the Persians spent in Greece, they seeded down alfalfa near their permanent camps to serve as feed for their chariot horses and to furnish greens for the ration of the soldiers. Alexander the



Alfalfa—Cox and Megee

Alfalfa seed on the left as it comes from the thresher contains a high percentage of impurities such as weed seeds, pieces of stone, chaff, etc., and also many thin, immature seeds. The clean sample on the right has been processed by thorough use of the fanning mill and other mechanical means in preparing this seed for the grower.

Great brought alfalfa into Italy, and Columella, writing of it in the first century A.D., states: "It [alfalfa] is the best feed for whatsoever kind of famished livestock. It dungs the land and provides five or six crops each year."

The name alfalfa is from the Arabian word alfalfacah, meaning best forage. Columella called this plant Lucerne, a term which is commonly employed in Europe and in our Western States.

The conquering armies of the Romans introduced alfalfa into the regions which are now included within the borders of

Germany, France, and Spain. The early Spanish gold seekers and conquistadors carried alfalfa with them to Mexico, Peru, Chile, and Argentina. Our own gold seekers, the Forty-Niners, were the first to introduce alfalfa into California and other

Seed Production and Marketing—Cox & Starr

Seed bearing apparently does not impair the longevity of alfalfa fields. In the memory of the Utah pioneer above, this field is over fifty years old and has borne seed for more than forty years.

Western States, where conditions proved remarkably favorable.

George Washington, interested in all plants of value to his country, experimented with alfalfa on his Fairfax farm, but was not successful in growing it, as he did not know that it was necessary to inoculate and to apply lime to his acid soils in order to raise this lime-loving crop. His friend, Thomas Jefferson, to whom he sent some seed, secured more favorable results at Monticello, on land that was better supplied with calcium carbonate.

In New York State, alfalfa has been grown with success since pre-Revolutionary days on the limestone soils of the Onondaga hills.

The spread of alfalfa has been accomplished chiefly by the migrations of conquering armies and the gold-seeking expeditions of history. With the passage of time, this unobtrusive plant has contributed more to the prosperity and happiness of nations than the conquerors and gold hunters who distributed it.

The present eastward movement of alfalfa in the United States has been made possible by scientific study of the needs of the plant and the development of practical methods which insure its successful production even under adverse conditions.

The planting of alfalfa was encouraged on the contracted acreage of the A.A.A. Crop Control Program and was made a practice for award under the Agricultural Conservation Program. Alfalfa acreage increased more than 20 per cent during the five years of these programs, the largest increase being in states east of the Mississippi.

SWEET CLOVER GROWING

Sweet clover has taken rank as a valuable forage crop. Recently considered a weed, it is now recognized as one of our best-adapted crops for pasturing livestock, as a hay crop, and as a green-manuring crop. Although sweet clover is grown to the greatest extent on soils deficient in organic matter, it is, nevertheless, very valuable on soils in a highly improved condition when used for hay or pasture, since it produces unusually large yields of high-protein forage, as either pasture or hay. Sweet clover has long been recognized as one of the most valuable honey crops.

The following practices give success with sweet clover:

1. Get good seed of the right variety.
2. Prepare a firm, clean seed bed.

3. Use lime and fertilizer where needed.
4. Inoculate soil where sweet clover or alfalfa has not been grown previously.
5. Plant in spring or early summer at depth of ½ to ¾ inch.
6. Cut for hay just before bloom appears, with mower-bar set high.
7. Cure hay in windrows or cocks.
8. Harvest seed-crop when the majority of seed hulls are brown.
9. Use sweet clover in ordinary rotations, or as a green-manuring crop where needed.

Get Good Seed of the Right Variety. The white-blossomed, biennial sweet clover is much better adapted to a wider range of conditions and for more purposes than the yellow-blossomed biennial. The biennial white has a more upright habit of growth and produces larger yields of forage than the biennial yellow, which has finer stems and is more decumbent. The Evergreen, an Ohio Experiment Station variety, stays green until late in the summer and is considered superior as a pasture variety. In the Midwest, the Madrid, a variety introduced by the United States Department of Agriculture from Spain, is proving superior for pasture and hay purposes. The seed of the biennial yellow has dark, purplish green mottlings and purplish green spots, and hence can be distinguished from seed of the biennial white when the latter is mixed with it.

The annual yellow sweet clover is grown to a considerable extent in southern California. It is a small, erect plant, which produces seed the first season and does not do well in the Corn Belt or the Northern States. The seed of the annual yellow is smaller than that of the biennial sweet clover.

The annual white sweet clover, commonly called Hubam, is a selection from the biennial sweet clover. It has been shown to be of some value as a green-manuring crop, a hay and pasture crop, and a cover crop in orchards.

Good seed of sweet clover should be clean, of bright color and good odor. Sweet clover seed of all varieties has a characteristic, pleasant, pungent odor, due to its coumarin content.

Mustard is a common weed of sweet clover. It is necessary to inspect the seed carefully, to be sure that it is of a high degree of purity. Northern-grown sweet clover should be secured for northern localities.

Prepare a Firm, Clean Seed Bed. Sweet clover seed starts best on a firmly compacted seed bed. Poor results are obtained on mellow, loose seed beds; hence the cultipacker, or weighted roller, should be used to fit the soil for this crop. Corn ground, or land from which other cultivated crops have been harvested, may be fitted for sweet clover by thorough disking and rolling.

Use Lime and Fertilizer where Needed. Sweet clover will not give satisfactory yields on acid soils; hence soils should be tested, and lime should be applied where needed. Usually, 1 to 2 tons of ground limestone, or 3 to 6 cubic yards of marl per acre, are needed to put acid soils in condition for the growing of sweet clover. The crop also responds to 200 pounds or more per acre of acid phosphate or of complete fertilizer.

Inoculate Soil where Sweet Clover Has Not Been Grown Previously. On land where clover or alfalfa has not been grown previously, it is necessary to inoculate the soil with proper bacteria to enable sweet clover to make use of the free nitrogen of the air.

Either pure cultures may be secured for the inoculation of the seed, or the soil method of inoculation may be used. The latter method consists in diluting 1½ ounces of carpenter's glue with a quart of warm water and sprinkling it over a bushel of seed spread out on a smooth floor. Stir the seed, and then sprinkle over it about a quart of very fine soil, obtained from a sweet clover or alfalfa field at a depth of 1 to 4 inches where roots were heavily loaded with nodules.

Plant in Spring or Early Summer at a Depth of ½ to ¾ Inch. Best seeding results are usually obtained if sweet clover is sown alone in early spring or on fall-sown wheat or rye, or with barley or oats. If seeded with barley or oats,

best results are secured if only a bushel of the barley or oats is used as a companion crop. From 12 to 15 pounds of scarified sweet clover per acre are generally sufficient. Sweet clover seeds have a hard seed coat; hence germination is increased by the scarification process, which abrades and thins the seed coat.

If unscarified seed is used, 15 to 20 pounds are necessary per acre; and of unhulled seed, 20 to 30 pounds. When unhulled seed is planted, it is usually planted in late fall so that winter action will crack the seed coat for satisfactory germination during the spring.

Cut for Hay Just before Bloom Appears, with Mower-Bar Set High. Sweet clover should be cut for hay just before the blossom buds appear. If bloom is allowed to show before cutting, a coarse, woody hay usually results. If cut sufficiently early, a high-quality, leafy hay can be obtained from sweet clover. The mower-bar must be set high enough to leave a 6- or 8-inch stubble, in order that a good second growth may result. The second year's growth of sweet clover does not rise from a crown, but propagates from buds in the axils of the branches and leaves on the lower portion of the stalk; hence a stem that is sufficiently long for numerous new branches must be left. If the mower-bar is raised by means of specially made shoes at either end, results are more satisfactory.

Cure Hay in Windrows or Cocks. Sweet clover hay is somewhat more difficult to cure properly than alfalfa. It should be allowed to wilt in the swath for 4 to 6 hours, then windrowed with a side-delivery hay rake and allowed to cure in windrows for a day or longer. Under exceptionally good hay-making conditions, curing may be accomplished in the windrows, but it is usually necessary to throw hay into small cocks after curing in the windrows for a day or so. The hay is left in the cocks until cured. Curing requires two or three days or a week, depending upon weather conditions.

Handling in this way prevents great loss of leaf. The leaves are nearly three times as rich as the stems in protein; hence

sweet clover hay should be harvested at the best time and handled in the best manner to give the highest percentage of leaf.

Harvest Seed-Crop when Majority of Seed Hulls Are Brown. Since the sweet clover plant does not mature all its seed at one time, it must be cut when 60 to 75 per cent of the seed pods are brown and before there has been much loss from shattering. The grain binder is usually used in harvesting. The crop should be harvested for seed when toughened by the dampness of light mist or dew. The sheaves should be placed in small open shocks for curing.

The ordinary grain thresher may be used in threshing sweet clover. The hulls are then removed from the seed with a clover huller or a sweet clover seed scarifier.

Use Sweet Clover in Ordinary Rotations or as a Green-Manuring Crop where Needed. Sweet clover may occupy the same place in common rotations in the Corn Belt and the Northern States as red clover. On light or infertile soils, it frequently gives greater growth and is more dependable. It is considered one of the best crops for pasture and for turning under to increase the content of organic matter and nitrogen in depleted soils.

Additional Information

Sweet clover is recognized by dairymen as one of the best pasture crops. Although cattle in general do not like it at first, after two or three days they will usually begin to eat sweet clover pasture readily and thrive on it. Cows and sheep seldom bloat on sweet clover pasture. It also makes excellent pasture for hogs.

For horses and livestock in general, well-made sweet clover hay is recognized as comparable in feeding value to high-quality alfalfa hay.

Poorly cured or moldy sweet clover hay should not be fed, since it may cause the death of cattle and horses.

SUGGESTIONS

1. How many acres of alfalfa are being grown in your township? In your county? When and by whom was alfalfa first grown in your township? Where is the oldest established field? How long is a stand usually maintained after planting? Who secured the largest yield in tons per acre of alfalfa during the past year? What is the average yield of alfalfa hay in your neighborhood? Of clover? Of mixed hay? Of timothy? What is alfalfa hay worth per ton?

2. Name the four most successful alfalfa growers in the neighborhood. Do they apply lime? How do they prepare the seed bed? When do they plant? With or without a nurse crop? What variety of seed do they plant? Where purchased? Where is the seed grown? Is inoculation necessary? If so, how accomplished? How much seed do they use per acre? How deep is it planted? When is the first cutting taken for hay? Do they cure in windrows or in cocks? How long is the crop allowed to wilt in the swath? Is the hay fed on the farm?

3. What do the four leading growers say of the value of alfalfa hay as a feed for dairy stock? For horses? For sheep? Is alfalfa used as pasture for hogs? For horses? For cows? For sheep? Inquire about the best methods of pasturing to conserve stand.

4. Ask the four best growers how corn, beans, potatoes, and other crops yield after a crop of alfalfa.

5. Dig up roots from fields four years old, or older. What is the length of the longest?

6. In a thrifty field of alfalfa, dig up other roots with dirt adhering and carefully wash. Note nodules on smaller surface roots.

7. Under what soil conditions is alfalfa most successful? Under what conditions are failures most frequent? Should more alfalfa be grown in your neighborhood? If so, tell how the growing of more alfalfa will add to the prosperity of your community.

8. Get seed of known origin, Grimm, common, and local. Plant drill-width or square-rod plats of each.

9. Judge various lots of alfalfa seed.

10. Secure from the state agricultural college bulletins dealing with alfalfa or sweet clover.

11. Is sweet clover grown in your locality? For what purposes is it used? Does it grow wild? What is the value of sweet clover?

12. Ask growers about methods of planting, making hay, harvesting for seed, pasturing, and using as soil-improving crop.

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CHAPTER XXVI

GROWING LESPEDEZA AND OTHER LEGUMES

Lespedeza. Lespedeza has spread with amazing rapidity throughout the lower part of the Corn Belt and the northern part of the Cotton Belt during the past ten years. It is doubtful if any legume or any other crop has increased as rapidly

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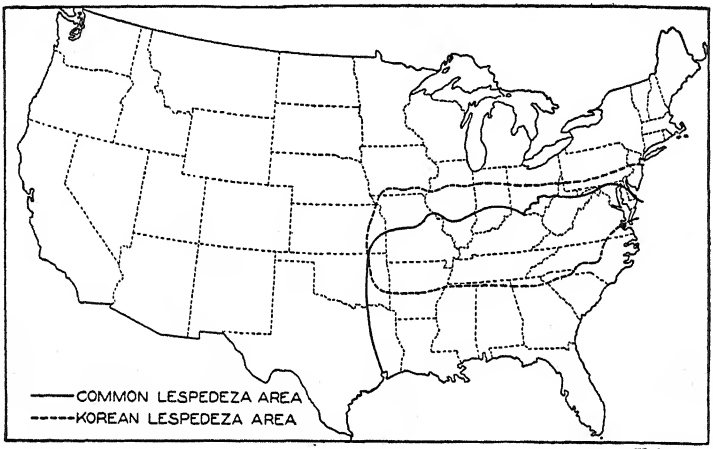
Single plants of Korean lespedeza. This crop has increased with remarkable rapidity in the lower Corn Belt and the northern Cotton Belt.

in acreage in so short a period of time as lespedeza. The chief reasons for this remarkable increase are the fact that lespedeza will grow on acid soils, whereas clover and alfalfa do not do well without additions of lime, and the fact that lespedeza is valuable in soil improvement and for pasture, hay, and seed purposes. Lespedeza does not yield so well as alfalfa and clover on fertile soils well supplied with lime, but on marginal land and on acid soils it gives comparatively better yields; it yields better on soils that are limed and fertilized. The seeds that fall to the ground insure reseeding and provide feed for quail and other birds during fall and winter.

Lespedeza is not new in Southern agriculture. Several varieties have been established among native grasses during the past century. It is frequently called Japanese clover in the South. Many believe that the movement of cavalry forces of the North and the South spread Japanese clover to many new districts in the South. Native hay, including les-



Map showing adaptation of common and Korean lespedeza.

pedeza, was collected for the use of cavalry horses and carried with the armies.

With the introduction of improved varieties by the United States Department of Agriculture, lespedeza rapidly became important as a cultivated crop. The leading varieties are the common lespedeza, which has been known in the South for more than a century, and the Tennessee No. 76, which is apparently a selection of the common since it resembles it in every way, but gives a higher yield of hay and pasture and is more erect in the field. The Kobe, also important in the Cotton Belt, is larger leafed and taller stemmed than the common. The seed also is larger.

Korean lespedeza is coarser, broader leafed, and considerably larger than the common. It matures seed earlier. The Korean lespedeza is of great importance in the southern part of the Corn Belt and the northern Cotton Belt.

Lespedeza sericea is a perennial plant, and it differs from the annual varieties. A new growth springs each year from the crown as with alfalfa but, after the first growth is cut, the second growth develops from the stubs like sweet clover.

Planting Lespedeza. Early spring plantings give best results. In Tennessee and North Carolina seed is generally planted in February and March; in Kentucky and Virginia, in March and early April; and in the lower part of Ohio, Indiana, Illinois, and Missouri, in April or early May. Seedings may be applied on winter wheat, winter rye, or winter barley, or made with spring-planted oats or barley. Old pastures to be planted to lespedeza may be improved by disking or harrowing early in the spring.

It is usual to plant 25 to 30 pounds per acre if a full stand of hay or pasture is desired the first year. Lighter rates of 10 or 15 pounds per acre usually make a fair crop and will produce ample seed to reseed the land for a full crop the next year. In seeding old pastures, 15 or 20 pounds per acre of seed are usually applied. The harvested seed of lespedeza should be scarified to insure a quicker start.

Pasturing Lespedeza. Lespedeza, if sown in the spring, is ready for pasture in late June or early July. Korean is about two weeks earlier than the common and Tennessee varieties. The Korean lespedeza will furnish pasture until early September, when the crop matures and seed ripens. Common and Korean usually stay green until frost. It is characteristic of the lespedezas to grow best during the hot summer weather. They furnish excellent pasture at a time when most pasture grasses, particularly bluegrass, provide little pasture, owing to heat and drought of midsummer and late summer. The seeding of old pastures with lespedeza greatly increases their carry-

ing capacity. This crop is highly esteemed for pasture purposes for all kinds of livestock wherever adapted.

Making Hay of Lespedeza. Haying begins when there is enough growth for cutting. The first cutting is usually made in late June or early July. The crop is easily cured, and its quality greatly improved by curing in windrows or small cocks for 1 or 2 days. Yields range from 1 ton per acre on thin upland soils to 2 or 3 tons on fertile soils. The second year, volunteer stands usually produce larger yields of hay than the first-year seedings. Older fields are likely to be weedy and will not produce as high-quality hay as the first or second year. In order to insure a volunteer crop the following year, if this is desired, the hay crop should be cut early and high enough to enable a second growth to produce seed before frost; or the cutting may be held off until sufficient seed has matured to shatter out while the hay is being cut. A good-quality hay results from the earlier cuttings. Lespedeza hay is relished by all kinds of livestock and, if properly cured, is reported to be nearly equal to alfalfa hay. In meeting the needs of the drought-stricken western region of 1934, large quantities of lespedeza hay were shipped west from Kentucky and Tennessee, and this hay gave excellent satisfaction.

Improving Soils with Lespedeza. Average yields of corn, cotton, and other cultivated crops, following lespedeza, are greatly improved. This crop is now known as one of the most effective soil-building crops for the southern part of the Corn Belt and the South, in general, wherever adapted. The comparatively low cost of planting lespedeza and the fact that this crop reseeds itself are considered advantages over most legumes. It is considered one of the best crops for adding nitrogen and organic matter, particularly in regions where there are extensive areas of infertile and acid soils.

Harvesting the Seed-Crop. In the harvesting of the Korean and the Kobe varieties, it is usual to cut and rake the crop while the dew is on, then to cure in the windrow, and to thresh with an ordinary grain separator. The combine har-

vester is used in the threshing of lespedeza seed, after the matured crop is cut with a mower and raked into windrows; when the lespedeza is cured, it is threshed with the combine with a pick-up attachment. Under favorable weather conditions the combine may be used in the harvesting of lespedeza seed in the same way that it is used in harvesting a grain

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Lespedeza furnishes excellent pasturage.

crop. In the harvesting of the common and Tennessee 76 varieties, which shatter easily, a pan to catch the seed is attached back of the cutterbar of the mower. Heavy seed yields, ranging from 12 to 20 bushels per acre, are generally produced by lespedeza, the seed weighing 25 pounds per bushel. After threshing, the seed should be cleaned with a good fanning mill.

Early clipping tends to reduce weeds, and a later clipping with the mower-bar set high, in midsummer, further reduces weed seeds harvested in the seed-crop. The weeds, if they are heavy, should be removed from the field. Very weedy areas in

large fields of lespedeza should not be harvested with the main crop for seed. The fact that much of the seed shatters and falls to the ground insures the reseeding of the annual lespedezas.

Growing Lespedeza in Rotation. Lespedeza lends itself well to the common rotation of the regions where it is adapted. The crop generally is seeded with or on small-grain crops, it follows the grain crop in rotation, and it occupies the land for 1 or 2 years or more. The following is a typical 4-year rotation:

First year—corn, cotton, or other cultivated crops
Second year—oats and barley seeded with lespedeza
Third year—volunteer lespedeza
Fourth year—lespedeza

Lespedeza sericea. A plant explorer of the United States Department of Agriculture found *Lespedeza sericea,* a perennial lespedeza, growing wild in eastern Asia. During the past twenty years, this crop has been on trial at the Tennessee, North Carolina, Missouri, and other experiment stations in the regions to which lespedeza is adapted. Substantial distributions of increases have been made. Of the perennial lespedezas, *Lespedeza sericea* is particularly valuable in the improvement of worn-out soil and the prevention of erosion. Without substantial applications of lime it will thrive on soils too deficient in calcium to give good results with alfalfa, clover, and sweet clover. The crop is exceedingly drought-resistant and grows with such vigor that it is not choked out by weeds and grass. It produces high yields of pasture and hay and outyields alfalfa as a hay crop on poor lands. Although the pasture apparently lacks palatability, dairy cattle, horses, and sheep can be maintained on sericea pasture with success. Lespedeza remains green during the period from midsummer to late summer when ordinary pastures are dormant. The hay is apparently adapted to the feeding of cattle, horses, and sheep. Although it tends to be coarse, experiments indi-

cate that early and properly cured sericea hay can take the place of alfalfa and clover hay in livestock feed.

Owing to the high price of seed, it has been the custom for most farmers to plant sericea in rows, using 4 or 5 pounds of

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Lespedeza sericea. A perennial lespedeza of proved value for erosion control and soil improvement. As a pasture crop and hay crop it is not relished by livestock in the same degree as Korean and common lespedeza.

seed per acre. Experiments indicate that 15 pounds of scarified seed per acre, drilled or broadcast, give better results. The unhulled seed starts slowly, and 25 pounds, or more, per acre is advised. Early spring seedings give best results. Though midsummer and early August seedings have been successful, summer seedings provide opportunity for thorough fitting of the seed bed and reduce the competition of weeds. A hay crop is usually not produced during the first year, although it is usually advisable to cut and remove grass and

weeds. During the second and subsequent years, hay crops are produced with great certainty, and ample growth is available for pasture. Two to four cuttings of sericea hay generally produce 2 to 3 tons per acre.

Seed is produced copiously, and the crop is usually harvested when 85 per cent, or more, of the hulls have turned brown.

Bur Clover. Bur clovers are annual legumes having small, yellow flowers. The seed is borne in tightly coiled, spiny pods or burs. The bur clovers are of importance in the Cotton Belt, California, and western Oregon and Washington. They are of particular value as good winter and spring pasturage for cattle, sheep, and hogs. They grow best on moist, well-drained, fertile soils. Poor soils should be fertilized with several hundred pounds of fertilizer high in phosphorus. Plantings are made in late summer or fall at the rate of 15 pounds of seed per acre and may be drilled or broadcast. The crop is seldom harvested for hay purposes owing to the light yields secured.

Velvet Beans. Velvet beans have gained rapidly throughout the Coastal Plains region of the South and are considered one of the most valuable legumes for use in soil improvement. From 15 to 25 pounds of seed per acre are required when planted with corn or millet, and 40 to 60 pounds when planted alone. Owing to the vigorous growth made by this crop, it is desirable to plant with corn, millet, or another crop that will hold up the vines when the seed is to be harvested. The crop is a heavy seed producer, producing 20 to 30 bushels of seed per acre. It is considered an excellent fall and early winter pasture crop for cattle. Velvet beans are planted in the spring, 15 to 20 pounds per acre.

Austrian Winter Peas. The Austrian winter pea is now considered a leading winter annual legume for cover-crop pasture and green-manuring purposes throughout the South. The seed is produced chiefly in Oregon and Washington. As a general rule, 40 pounds per acre are planted. Plantings begin in the northern part of the Cotton Belt after the middle of September and in the southern part of the Cotton Belt in mid-

October. Inoculation is advisable when this crop is introduced for the first time in a particular locality.

Kudzu. Kudzu is a valuable soil-improving and forage crop adapted to the Southeast. It is a perennial leguminous vine brought to this country from Japan. Owing to its vigorous root system and vine growth, kudzu is particularly useful in stopping erosion in gullies and on steep hillsides. The crop may be grazed or harvested for hay. Its growth becomes woody in regions where it is not killed to the ground by frost.

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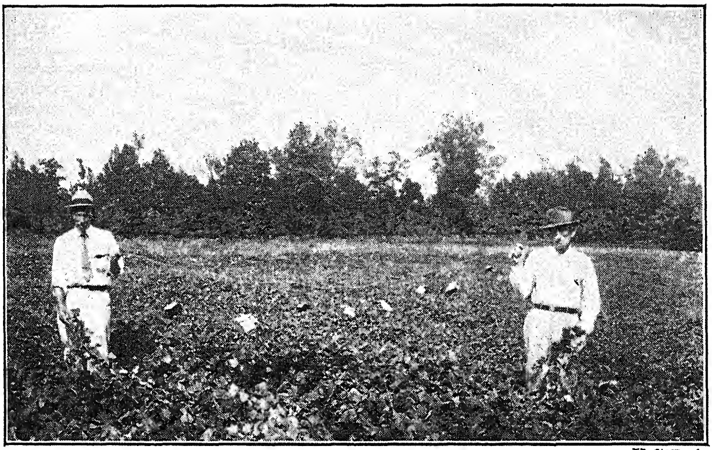
Velvet beans are a popular soil-improving and forage legume in the South.

Kudzu is established by the setting out of rooted plants 2 years old or older. The plants are usually set 3½ by 3½ feet, but the cost of planting can be reduced if the plants are spaced every 3½ feet in rows 7 feet apart, and if a row of corn or other cultivated crop is grown between two rows of kudzu the first season. About 1800 plants are required per acre if

spaced $3\frac{1}{2}$ by 7 feet. The plants should be cultivated for the first and often for the second year to control weeds.

When established a field of kudzu will provide hay and pasture for many years. It is conceded that where alfalfa, clover, or lespedeza can be grown, kudzu has little place in the cropping program. However, on poor soil, very steep soils,



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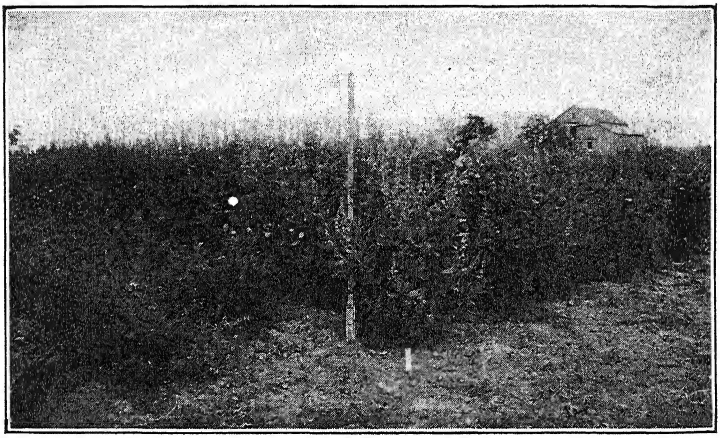
Kudzu is a valuable viny legume used for soil improvement, stopping gullying, and pasturage in the Cotton Belt.

and on the sides of gullies this crop is a valuable one. It is not adapted to planting farther north than Washington, D. C. Its chief place is on sub-marginal land particularly where moisture is often deficient, in the South or Southeast. Dr. A. J. Pieters of the Bureau of Plant Industry, Washington, D. C., suggested that the Southern farmer plant a small area to kudzu to be expanded if the crop proves profitable. He can dig his own roots and extend the plantings at a minimum of cost.

Crotalaria. This vigorous, summer-growing legume is of considerable importance in Florida as a green-manuring crop

and is adapted, in general, to most of the Cotton Belt, in regions of ample rainfall. *Crotalaria striata* is a wider-stemmed, taller-growing species. The plants often reach a height of 4 or 5 feet. It is considered better adapted to dry sandy soil. The seed of *Crotalaria striata* is brown or olive



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Crotalaria spectabilis is a valuable soil-improving crop in regions of ample rainfall in Florida and the Gulf States. Its value for forage is limited.

green in color. *Crotalaria spectabilis* is finer stemmed; the seed is black. Both species are killed by temperatures of 28° F. or lower. Strains of crotalaria that are palatable for livestock have not, as yet, been developed. The seed is planted from April to June in well-fitted seed beds, 20 pounds of seed per acre, either broadcast or planted in rows. The seed should be scarified before planting. Inoculation is apparently not necessary since natural inoculation occurs throughout the Cotton Belt. Crotalaria is remarkable as a crop that will produce an abundance of organic matter and that will greatly increase the nitrogen in the soil. If it is turned under at a succulent

state of growth, decomposition and incorporation with the soil take place rapidly.

SUGGESTIONS

1. Secure from the state agricultural college bulletins describing the use of lespedeza and other special legumes which may be suitable for the farming program.
2. Make plans for growing such legumes in trial plots to determine their use in a specific farming program.
3. Learn about the experiences of farmers who are using such legumes in their farming programs.

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CHAPTER XXVII

GROWING GRASSES AND LEGUMES FOR HAY AND PASTURE

Grass, the most important of all crops, has been the most neglected.

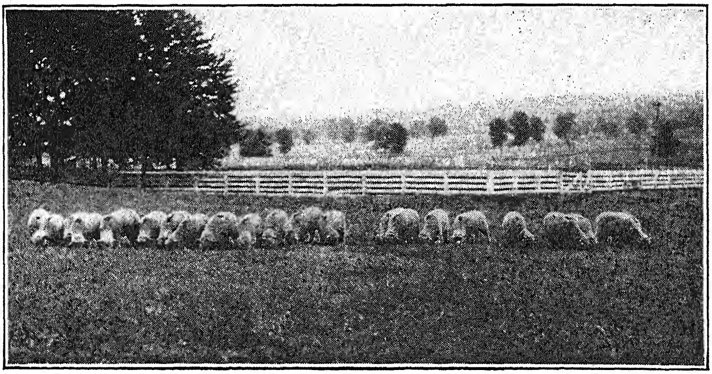
The grasses which furnish pasture and hay are as necessary to our prosperity as the grain crops. Meat and milk production and the maintenance of horses, which are needed in the nation's work, depend very largely on the grass crops. The upkeep of soil fertility also is largely dependent on the maintenance of good sods. To realize the importance of grasses in the Corn Belt and the Northern States, consider the prospects of these regions without the ever-present grass growth—bare roadsides, eroded hills, the earth devoid of its velvety carpet, no sign of vegetation in yards and fields not occupied by cultivated crops—truly a cheerless prospect.

Skill in the handling of pastures and the management of meadows is as certain of reward as proper methods applied to the handling of other crops. We are too inclined to take the grasses for granted and to think very little about them and the methods of getting best results from their use.

1. Choose grasses adapted to your conditions.
2. Get good seed.
3. Use best methods in planting seed.
4. Give pastures and meadows proper care.
5. Cut hay at the right stage of growth.
6. Use an efficient method of curing hay.
7. Store in mow, stack, or bale.

Choose Grasses Adapted to Your Conditions. Over most of the Corn Belt and the Northern States, *Kentucky bluegrass*, or

June grass as it is commonly called, comes in naturally and is apparently the best-adapted pasture and lawn grass. This grass does well under all conditions except the most adverse of this region. *Canadian bluegrass* forms a natural grass cover in lower Canada and is of importance in the Northern States on heavy clays and poorly drained lands.



U.S.D.A.

Increasing our acreage of pastures and meadows conserves and improves the land, cheapens the cost of feeding livestock, and improves the quality of livestock products.

Timothy is our most important hay grass. It is adapted to fertile loams, silt loams, and clay loams of the Corn Belt and the Northern States. Timothy gives best yields on fertile, moisture-retentive soils. It does not do well on sandy or droughty soils or on poorly drained lands.

Redtop is next in importance to timothy as a common hay grass. It will grow under conditions not favorable to timothy; it makes a very strong growth on soils too moist to give good timothy and also does better on light soils. Redtop approaches bluegrass in its characteristics and forms more of a sod than timothy. It is fairly tolerant to acid soil, upon which timothy will not do well.

Orchard grass also will do better than timothy on wet, dry, and acid soils, and is better suited to seeding in woodland pastures or cut-over lands, since it will give more growth under shaded conditions.

Southern States Cooperative

A good type of rotary hand seeder for seeding grass and legume seed is an important implement on the farm.

Meadow fescue is often seeded in pastures, and it furnishes excellent late-summer growth, since it has deeper roots than the ordinary pasture grasses.

Sheep's fescue will make a sod on soil too light for successful formation of a bluegrass sod. It is adapted to much the same climatic conditions.

Brome grass forms a great network of underground root stalks and is very resistant to droughty conditions. It is grown in the Northwestern States and Canada, and occasionally in the Northern States and is valuable for both hay and pasture. Brome grass and alfalfa mixtures are giving highest yields of pasture and hay in the Northern States and the Corn Belt. The Lincoln Brome, a variety developed by the Nebraska Experiment Station, is considered the best available for Midwest and Corn Belt planting. Brome grass and ladino mixtures are giving excellent results in New England and New York. (Note pages 436–438 for information on additional grasses.)

Get Good Seed. Grass seed should be of high purity, of bright, lively color and fresh odor. The percentage of weed seeds, chess, hulls, and other impurities should be very small, less than a fraction of a per cent. Germination should be as good as can be obtained. In timothy, a germination of 95 per cent or better is characteristic of good seed. Kentucky bluegrass seldom gives a germination of more than 70 per cent.

Common weed seeds, such as the docks, thistles, mustard, quackgrass, and so on, are commonly carried in grass seed. Costly infestation may easily occur through carelessness in planting impure seed. Inspect seed carefully and make a germination test, or send sample to your state seed-testing laboratory for analysis.

Timothy seed is produced mostly in southern Minnesota and Iowa, although timothy seeds dependably and copiously in the northern part of the Corn Belt and in Northern States.

Kentucky bluegrass seed is produced mostly in the bluegrass region of Kentucky and in western Missouri.

Canadian bluegrass is produced in southern Ontario and Quebec. It frequently carries Canada thistle seed.

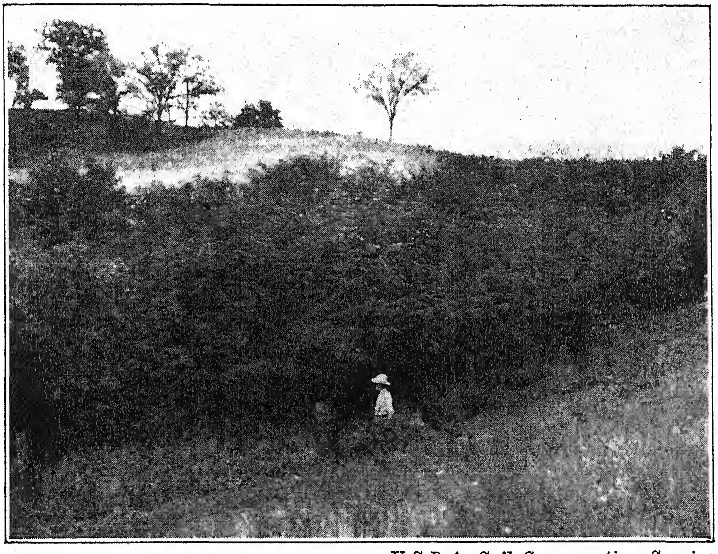
Use Best Methods in Planting Seed. The seed of grasses for pasture and meadows should be planted at the right time, on seed beds that are in good condition. Care should be taken not to plant too deep. Grass seeders, which broadcast the seed

evenly, are generally used; but the seeding is sometimes made with an attachment on a drill, or with a special grass-seeding drill.

In general, grass seed should be barely covered on firmly prepared ground. Usually, seedings are made with a companion crop of small grain. Grass seed is generally seeded with clover.

Table 26 gives some of the standard mixtures for various soils, and rates of planting. (See pages 432–433.)

Give Pastures and Meadows Proper Care. Both pastures and meadows respond to good drainage and proper fertilization. The top dressing of pastures and meadows with manure and proper commercial fertilizers, such as 150 to 250 pounds per acre of acid phosphate, ammoniated phosphate, bone meal, or complete fertilizer, applied when growth starts in the spring,



U.S.D.A. Soil Conservation Service

Hill slopes in grass crops and trees planted in gullies provide pasture for livestock and feed and cover for game and wild life.

TABLE 26

Grass and Clover Seed Mixtures for Hay and Pasture

Hay and Permanent Pasture on Well-Drained Loam

	Pounds per Acre
Kentucky bluegrass	4 – 6
Timothy	3 – 4
Red clover	4 – 5
Alsike clover	2 – 4
White clover	½– 1
	13½–20

Hay and Permanent Pasture on Sandy Loam

	Pounds per Acre
Kentucky bluegrass	4 – 6
Orchard grass	5 – 7
Redtop	3 – 5
Red clover	3 – 5
Alsike clover	3 – 4
White clover	½– 1
	18½–28

Hay and Permanent Pasture on Poorly Drained Loam

	Pounds per Acre
Kentucky bluegrass	4 – 6
Redtop	2 – 3
Canada bluegrass	2 – 3
Timothy	1 – 3
Alsike clover	2 – 4
Red clover	3 – 5
White clover	½– 1
	14½–25

Hay on Well-Drained Loam

	Pounds per Acre
Red clover	7– 9
Timothy	5– 9
	12–18

TABLE 26 (*Continued*)

Hay on Variable Soils

	Pounds per Acre
Red clover	6– 8
Alsike clover	2– 4
Timothy	4– 8
Redtop	2– 4
	14–24

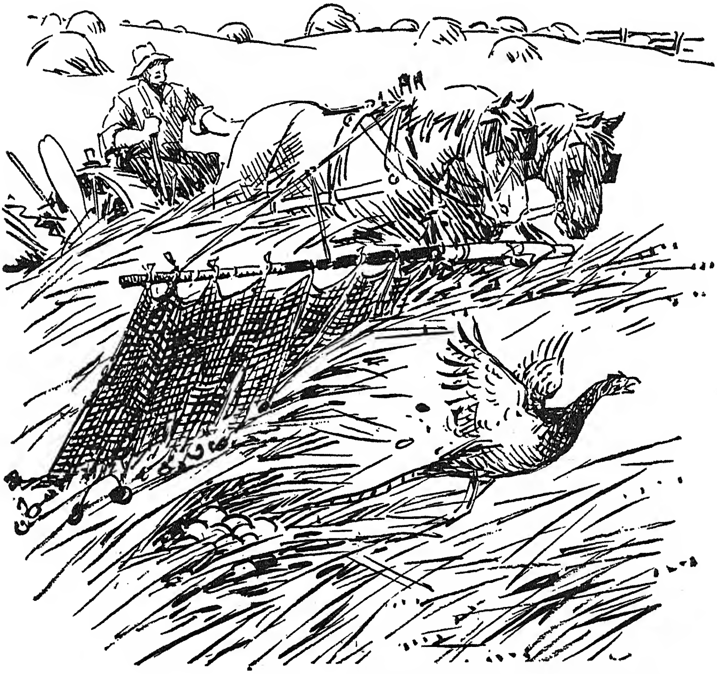
gives a marked increase in hay and pasture. Timothy meadows, so treated, often increase production to the point at which the fertilizer is paid for in the hay crop. Following crops of corn, planted after the meadow is plowed, also give much higher production, owing not only to the residual effect of fertilizers applied, but also to the greater amount of organic matter which is present in the soil as a result of a more vigorous grass growth.

Cattle, sheep, or horses should not be turned on pastures too early in the spring or allowed to crop them too close at any time. Proper grazing increases the productivity of pastures and keeps them fairly free of weeds. All weeds should be cut before the seed is formed. The cutting of weeds and briers twice a year will usually keep them in check.

Timothy and mixed-hay meadows should not be cut for hay or used for pasture for too long a period, since the hay yield becomes less year by year and the number of weeds increases. After the second or third year, the ground should be plowed and planted to a cultivated crop.

Cut Hay at the Right Stage of Growth. The best quality of hay is made when cut at the right stage of maturity. Usually this is when the hay is in the stage of bloom before seeds have formed. Timothy, orchard grass, and other hay grasses, cut at this stage, will produce a pliant, leafy hay. If it is allowed to get too ripe, the hay becomes woody, less palatable and nutritious, and the leaves are more easily lost in han-

dling. It is a common fault to let timothy get too ripe in the field; but one of the advantages of timothy is that it suffers less than most hay grasses from being cut somewhat



Darling, U.S.D.A. Farmers' Bul. 1759

Farmers interested in Game Conservation should protect nests of pheasants and quail by using a device such as the above to flush nesting birds ahead of mower-bar, which may be raised to leave a small patch of uncut hay around the nests.

later than is desirable. Good hay should carry a high percentage of leaves; in overripe timothy, the leafiness is decreased through fungus diseases, such as anthracnose, and a more stemmy hay of lower quality results.

Use an Efficient Method of Curing Hay. It is customary to allow hay from timothy and other grasses to cure in the swath

and windrow. Hay of best quality can be secured if it is allowed to wilt only in the swath, thrown into a windrow, and cured in the windrow. If rained upon, the windrows should be turned.

In order to reduce the cost of handling hay and to insure as good quality as can be produced, the best type of hay-making machinery should be available and should be kept in good repair. Mowers should be kept well greased and oiled and should be overhauled before the haying season. Knives should be sharpened, and extra knife blades and other parts needed should be ordered before the season begins. Rakes and loaders should receive the same attention.

Owing to the present high cost of labor, modern hay making must be placed on a machinery basis, the fork being used as little as possible in handling hay. If a large acreage is handled, a full equipment of mowers of the best quality, side-delivery rakes, field loaders, and stacking machinery will prove economical.

The left-hand side-delivery rake has an advantage since it tends to throw the heads and leafy parts of the stems toward the center of the windrow. The rake follows the mower in the same direction and works against the heads.

Store in Mow or Stack, or Bale. After being cured, the hay should be put under cover when sufficiently dry or made into well-built stacks. (See Chapter XIII.)

Regional Adaptations of Major Grasses and Legumes. The grasses and legumes of importance for pasture are also the most important for hay purposes and for soil conservation. The classification in Table 27, according to adaptation of major grasses and legumes for permanent pasture, was prepared by Messrs. H. N. Vinall and C. R. Enlow of the United States Department of Agriculture, Bureau of Plant Industry.

Grasses Desirable in Permanent Pastures. In Table 27 are listed the most important tame grasses which occur in our productive and permanent pastures. This table supplies information on climatic and soil adaptations, palatability, time and

TABLE 27

Information Regarding Grasses for Permanent Pastures *

Name	Climatic Adaptation †	Degree of Palatability	Season of Grazing	Time and Rate of Seeding per Acre	Soil Adaptation	Remarks
Bahia grass (*Paspalum notatum*)	Section 2*b*	High	Early spring to late fall	Early spring; 10 to 15 pounds	Sandy loam to sand	Seed expensive and of low germination
Bermuda grass (*Cynodon dactylon*)	Region 2 and sections 3*b* and 4*b*	Medium	Late spring to early fall	Early spring; 5 to 8 pounds	Loams, clays, and silts	Propagated to a large extent vegetatively
Brome grass or smooth brome (*Bromus inermis*)	Western part of section 1*a* and sections 3*a* and 4*a*	High	Very early spring to late fall	Early spring or early fall; 15 to 20 pounds	Practically any type	Becomes sod-bound quickly
Canada bluegrass (*Poa compressa*)	Region 1 and sections 3*a* and 4*a*	High	Early spring to late fall	Early spring or fall; 15 to 20 pounds	Almost any type	Succeeds on poor soils
Carpet grass (*Axonopus compressus*)	Region 2	Medium	Spring to fall	Early spring; 8 to 12 pounds	Moist sandy or sandy loam	Makes a very tight turf
Centipede grass (*Eremochloa ophiuroides*)	Southern half of region 2	Medium	Spring to fall	Early spring use sod or stolons, no seed available	Almost any type	Makes a close turf and is very aggressive crowding out weeds, legumes, and other grasses when once established
Crested wheat grass (*Agropyron cristatum*)	Sections 3*a* and 4*a*	High	Very early spring to late fall	Early spring; 12 to 15 pounds	Almost any type	Drought-resistant, easy to get a stand
Dallis grass (*Paspalum dilatatum*)	Region 2 and sections 3*b*, 4*b*, and 5*b* where irrigated	High	Early spring to late fall	Early spring or fall; 8 to 12 pounds	Any fairly productive soil	Seed expensive and often of low germination, difficult to get a stand
Johnson grass (*Sorghum halepense*)	Region 2 and sections 3*b*, also 4*b* where irrigated	High	Spring to fall	Early spring; 20 to 25 pounds	Loams and clays	Productiveness decreases rapidly when grazed, very difficult to eradicate

Kentucky bluegrass (*Poa pratensis*)	Region 1 and section 5*a*, also 3*a* and 4*a* where moisture is plentiful	High	Spring to late fall	Early fall; 15 to 20 pounds	Sandy loams to clays of high productivity	The leading pasture grass on good soils in the North
Meadow fescue (*Festuca elatior*)	Region 1 and sections 5*a*, also 4*a* where moisture is plentiful	High	Early spring to late fall	Early fall; 20 to 25 pounds	Loams to heavy clays	Valuable in section 5*a*, of limited value elsewhere, disappearing rather quickly except on heavy moist clays
Meadow foxtail (*Alopecurus pratensis*)	Sections 1*a* and 5*a*, also 4*a* at high altitudes	High	Early spring to late fall	Early fall; 20 to 25 pounds	Moist sandy loams to clay	Very useful in pasture mixtures on wet soils, especially in 5*a*
Orchard grass (*Dactylis glomerata*)	Region 1, also sections 3*a*, 4*a* and 5*a* where moisture is plentiful	Medium to high	Early spring to fall	Early fall or early spring; 20 to 25 pounds	Any soil type except sand, if not too wet	Inclined to grow in bunches unless seeded thickly
Para grass (*Panicum purpurascens*)	Section 2*b*	High	Spring to fall	Early spring, no seed available	Wet soils	Propagated by planting pieces of stem or sod
Perennial rye grass (*Lolium perenne*)	Southern half of region 1 and in section 5*a*	High	Early spring to late fall; winter grazing in section 2*a* to limited extent	Very early fall (or spring in North); 20 to 25 pounds	Sandy loams to clays of medium to good fertility	Used little in pasture except in section 5*a*
Redtop (*Agrostis alba*)	Region 1, 2, and section 5*a*; also under irrigation and in mountain meadows, sections 3*a* and 4*a*	Medium	Early spring to late fall	Early fall best, early spring fair; 10 to 12 pounds	Grows on majority of soil types; prefers moist soils	Redtop of most value on poorly drained soils too wet for other grasses

* By H. N. Vinall and C. R. Enlow, U.S.D.A.

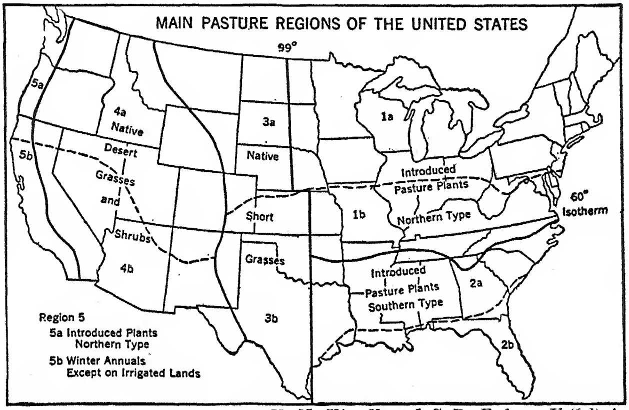
† The region and section numbers refer to the map on page 439.

TABLE 27 (*Continued*)

Name	Climatic Adaptation ‡	Degree of Palatability	Season of Grazing	Time and Rate of Seeding per Acre	Soil Adaptation	Remarks
Reed canary grass (*Phalaris arundinacea*)	Sections 1*a* and 5*a*, also 3*a* and 4*a*, where moisture is plentiful	Medium	Spring to fall	Very early spring; 8 to 12 pounds	Loams to heavy clays	Seed very expensive; very good for wet lands, will endure submergence
Rescue grass (*Bromus catharticus*)	Region 2 and where moisture is sufficient in sections 3*b* and 4*b*	Medium	Fall to spring (winter pasture)	Early fall; 20 to 25 pounds	Sandy loam to clay loam	An annual used in some localities for winter and spring grazing
Rhodes grass (*Chloris gayana*)	Section 2*b*; also southern parts of 3*b* and 4*b*	Medium	Spring to fall	Spring; 10 to 12 pounds	Loams to clays	Found most useful in the dry sections of southern Texas where other grasses fail
Slender wheat grass (*Agropyron panciflorum*)	Northern parts of sections 3*a* and 4*a*	High	Early spring to late fall	Early spring; 15 pounds	Practically any type, except sand	Better for hay than pasture; inclined to be stemmy
Tall oat grass (*Arrhenatherum elatius*)	Sections 1*b* and 5*a*	Medium	Early spring to late fall	Early fall; 20 to 25 pounds	Practically any type, except sand	Better in hay mixture; than for pastures stemmy, used most for pasture in section 5*a*
Timothy (*Phleum pratense*)	Region 1 and section 5*a*, also 3*a* where moisture is sufficient	High	Early spring to late fall	Early fall (or early spring); 12 to 15 pounds	Practically any type, except sand	Comes quickly and furnishes much pasturage at first, but is not permanent

‡ See map, page 439.

rate of seeding, the season of the year when they must be expected to furnish grazing, and other pertinent facts affecting their grazing value. No attempt has been made to include native grasses, the seed of which is not available commercially.



H. N. Vinall and C R. Enlow, U.S.D.A.

The kinds of grasses and legumes which provide most of the pasturage in the United States vary with both soil and climatic conditions. The five natural pasture regions as determined by the climate are indicated in solid lines on the map, and each of these regions is subdivided by dotted lines into sections *a* and *b*, chiefly because of their temperature relations. On the Pacific slope, however, the dotted line separates the more or less humid northern section from the drier southern part. The discussion will refer to these sections by number so that the reader should have the map constantly in mind.

Grasses for the Northern States.[1] There are a great many northern grasses to choose from in the planning of pasture mixtures for the humid areas of the Northern States. The ones more commonly used are timothy, Kentucky bluegrass, redtop, orchard, perennial rye, tall meadow oat, meadow fescue, Canada blue, and brome grass. In the more arid regions,

[1] Note map of regional adaptations, above.

crested wheat grass, brome grass, and slender wheat grass are used with considerable success.

Perennial Rye Grass. This grass is fairly common in section 5*a*, where it is quite well adapted. It gives good grazing and makes good hay, but is not sufficiently winter-hardy to be used in the extreme northern states, and the abundance of short-lived plants that are present in a planting from commercial seed causes the stand to thin out in 2 or 3 years.

Tall Meadow Oat Grass. This grass is valued for the early grazing it affords in the spring. It is useful only in mixed seedings and is best adapted in sections 5*a* and 1*b*.

Meadow Fescue. This grass is a desirable pasture and hay plant in section 5*a*, the mountain meadows of section 4*a*, and the western part of section 1*b*. In these sections it is a permanent grass, but seedings farther east in the Corn Belt are generally short lived.

Reed Canary Grass. This is an excellent grass for wet lands, but does well also on upland soil. It is a northern grass and probably will be of most value in sections 1*a* and 5*a*. Reed canary grass is subject to becoming sod-bound with age. Heavy disking or shallow plowing would probably cause renewed growth.

Canada Bluegrass. This is a grass which is particularly well adapted to the poorer soils of section 1*a* where it makes a good addition to a pasture mixture. It makes a thin wiry growth, but is readily grazed and appears to be very nutritious.

Brome Grass, or Smooth Brome. This is a very palatable grass which deserves a place in drier regions. It tends to become sod-bound and forms such a close turf that legumes and other grasses are not able to grow with it in mixtures.

Kentucky Bluegrass. Of all the introduced grasses, this is the most important from a pasture standpoint, and because of its use on lawns is most widely distributed. In many sections of our Northern States it appears spontaneously in fields that are not cultivated for several years. Because of this characteristic, seed of it may be omitted from pasture mixtures in

natural bluegrass areas, and it will gradually invade the field and finally become the dominant grass if soil conditions are favorable for its growth.

Meadow Foxtail. This grass is not so well known as the other grasses recommended for pasture seeding. It has been found most useful on wet soils in section 5*a*, but is also much at home in the high mountain meadows of section 4*a*. A more extensive use of meadow foxtail on wet soils in region 1 is justified.

Orchard Grass. This grass is not so palatable as several of the well-known grasses, but contributes very materially to pasturage because it endures shade better than most grasses and is more productive on soils of low or moderate fertility. It begins growth early in the spring and the excess growth in the fall provides considerable winter grazing.

Redtop. Like orchard grass, redtop is not relished especially by livestock, but is generally included in the pasture mixtures because of its ability to grow on poorly drained, acid soils.

Slender Wheat Grass. This grass is perhaps better suited for use as a hay plant than for pasture. However, until the introduction of crested wheat grass, slender wheat grass and brome grass were the only grasses available which could be grown successfully under the unfavorable climatic conditions prevailing in the northern Great Plains and adjacent areas in Canada. Mixtures of slender wheat grass and sweet clover are usually preferable for grazing to pure stands of either.

Timothy. Timothy is distinctly a hay grass, and from the time of its introduction until recently, when automobiles supplanted horses and mules in the cities, timothy was the leading tame hay on our markets. Its use in pasture mixtures is warranted, however, because it grows rapidly from seed and is leafy and palatable, providing abundant, excellent pasturage while the lower-growing turf grasses are becoming established.

Colonial (Rhode Island) Bent and Creeping Bent. These grasses are found in many pastures in the New England States,

and a form of creeping bent, known as Seaside Bent, is abundant on moist soils in region 5. These are all more valuable in lawns than in pastures.

Red Fescue (*Festuca rubra*). This is a fine-leaved persistent turf-forming grass which is of little value in pasture mixtures because cattle do not find it palatable. It grows best in the shade and is valuable in lawn mixtures.

Sheep's Fescue (*Festuca ovina*). This grass is a near relative of red fescue, which is a small bunch grass, very drought-resistant and of some value on sheep ranges.

Crested Wheat Grass. This is an importation from Russia which endures extremes of drought and cold and shows much promise for regrassing land in the northern Great Plains that was put in cultivation during World War I.

Grasses for the Southern States.[2] The southern grasses which contribute most to the pastures are the Bermuda, carpet, and Dallis grasses. Those less commonly found in pastures are the Johnson, centipede, Rhodes, Napier, rescue, and Vasey grasses. Para, Bahia, Guinea, and molasses grasses are hardy only in the sub-tropical belt along the Gulf Coast, indicated on the map as section 2*b*. They can also be grown on irrigated lands along the Mexican border, in sections 3*b* and 4*b*.

Carpet Grass. This is a turf grass which is persistent and aggressive on moist sandy soils and often appears spontaneously in region 2 where the land has been cleared and grazed heavily while protected from fires. It endures close grazing very well, but is not very productive, only fairly nutritious, and makes such a close turf that it is very difficult to keep legumes in it.

Bermuda Grass. This grass has spread naturally on loam, clay, and silt soils over most of the Cotton Belt and even a little north of the 60° isotherm. It starts late in the spring and ceases growth at the first light frost in the fall. In the irrigated sections of 3*b* and 4*b* Bermuda grass produces viable

[2] Note map of regional adaptations, page 439.

seed and spreads out into the cultivated fields, where it is a nuisance.

Dallis Grass. This is a long-lived perennial grass, which though less abundant than carpet and Bermuda is becoming increasingly important as a grazing plant in region 2. It is a bunch grass, and the turf is more open than that of the two first named. The growth of basal leaves is luxuriant, and Dallis grass pastures are both productive and nutritious. The chief drawback is the difficulty of obtaining a good stand. A fungus (*Claviceps paspali*) in the seed heads, which, if eaten in any quantity by cattle, causes a disease known as ergotism, may easily be controlled if the production of seed heads is prevented through heavy grazing or mowing the pasture.

Johnson Grass. Although it is best known as a pest in cultivated fields, Johnson grass is also found in pure stands where it is utilized as a hay crop and to a lesser extent as pasture. When grazed closely and continuously it gradually becomes unproductive and is not very desirable in pastures.

Centipede Grass. A rather recent introduction from China, centipede is an aggressive, stoloniferous grass, much like carpet grass in its tendency to form a very compact turf which gradually excludes other grasses and legumes and leaves pure stands of centipede grass. Such centipede grass pastures are low in productivity, and their nutritive qualities are questionable. Centipede grass will grow on moist soil types but appears to best advantage on sandy soils of the Norfolk series.

Rhodes Grass. This grass has been tested in most parts of region 2 and sections 3*b* and 4*b*, but has achieved importance only on some of the large ranches in southern Texas, where a drought-resistant plant is required. It will grow on moderately alkaline soils but is less palatable under such conditions. Seed is expensive and difficult to obtain in quantity.

Vasey Grass. This closely resembles Dallis grass but has fewer basal leaves and is less valuable for pastures. It comes in spontaneously on the rice and sugar-cane lands of southern Louisiana.

Rescue or Arctic Grass. This is a winter annual that often reseeds naturally in southern Texas. It appears usually at the end of the dry summer season and provides grazing after Bermuda grass has become dormant.

Para Grass. This grass is characterized by its long coarse trailing stems and very rapid growth under favorable conditions. It is very sensitive to low temperatures and is of most value on wet lands. No seed is available; therefore it must be propagated vegetatively.

Bahia Grass. This grass is not grown to any extent except in Florida. It is of most value on poor sandy soils. Seed is expensive and usually of low germination.

Guinea Grass (Panicum maximum). This is a large coarse bunch grass that is very drought resistant and one of the most dependable pasture grasses of the West Indies. In the United States it has never become popular but should be valuable in southern Texas where Rhodes grass has succeeded.

Molasses Grass (Melinis minutiflora). This is one of the most productive grasses in Brazil and Colombia, South America, where it is known as Gordura. It has fine stems and makes a very dense leafy growth about 2 feet deep over the ground. The leaves and stems exude a sticky sweetish fluid which gives the grass an odor. Cattle dislike the grass at first, but later appear to relish it and thrive on it to a remarkable degree. It can only be grown in practically frost-free localities such as the southern half of Florida.

Natal Grass (Tricholaena rosea). Natal grass was introduced from South Africa but has become naturalized in southern Florida and has spread to citrus groves and uncultivated land including the roadsides. Natal grass appears well adapted to the climate and the sandy soil of this part of Florida, but it is not relished by livestock and contributes little to the pasturage resources of the United States.

Legumes Desirable in Permanent Pastures. In Table 28 are listed the legumes which, alone or in mixture with the grasses previously described, contribute most to the produc-

tiveness of permanent pastures. This table supplies information respecting the climatic and soil adaptations, palatability, time and rate of seeding, season of the year when available for grazing, and the other facts affecting grazing value. No attempt has been made to include the native legumes where seed is not available commercially, nor introduced species which are of only minor importance in pastures.

Suggestions Regarding the Use of Various Legumes

Alfalfa. Although alfalfa has been used extensively for grazing in the West, it has not been much used in the Eastern States because of frequent losses of livestock by bloat and because of the injurious effect of grazing on the stand. If the crop is allowed to become quite mature before grazing, both troubles are avoided to a large extent, but the full feed value of the crop is not realized. The most profitable practice appears to be to cut the first crop for hay and allow later crops to be grazed during the balance of the season. Apparently the stand of alfalfa may be maintained if not grazed too severely and if the animals are removed sufficiently early in the fall to allow the alfalfa to reestablish the exhausted food reserves in the root system. The planting of alfalfa and brome grass mixtures for grazing and hay purposes has recently increased greatly, and cattle losses from bloat have been greatly reduced.

Alsike, Red, and White Clovers. These clovers are too well known and commonly used for grazing to need discussion. Alsike and red clover are included in the majority of pasture mixtures recommended in those sections where adapted, but generally do not last more than two years. White clover seldom provides much grazing until the second season but, if the pastures are kept fairly well grazed, it is quite permanent, although it is much more prevalent in some years than others. All three are very responsive to phosphatic fertilizers, and red clover in particular requires neutral or only slightly acid soils.

TABLE 28

Regarding Legumes for Permanent Pastures *

Name	Climatic Adaptation †	Degree of Palatability	Season for Grazing	Time and Rate of Seeding per Acre	Soil Adaptation	Remarks
Alfalfa (*Medicago sativa*)	All regions where moisture is sufficient, but only locally in region 2	Very high	Spring to early fall; winter grazing in Southwest, where irrigated	Depending on location—consult state experiment station	Practically any fertile soil type not wet or acid	Good pasture, but danger of bloat
Alsike clover (*Trifolium hybridum*)	Chiefly region 1 and section 5*a*; in sections 3*a* and 4*a* if moisture is sufficient; winter crop in region 2	Very high	Early spring and fall	Early spring; 8 to 10 pounds	Practically any soil type, except sands; will stand slight acidity	Especially suited for wet land
Red clover (*Trifolium pratense*)	Chiefly region 1 and section 5*a*; in sections 3*a* and 4*a* if moisture is sufficient; winter crop in region 2	Very high	Early spring to fall	Early spring; 10 to 15 pounds	Practically any well-drained soil if not acid	Use locally adapted seed
Mammoth red clover (*Trifolium pratense var.*)	Region 1, chiefly section 1*a*	High	Early spring to fall	Early spring; 10 to 12 pounds	Practically any well-drained soil, not more than slightly acid	Will endure slightly more soil acidity than common red
White clover (*Trifolium repens*)	All regions where moisture is sufficient	Very high	Early spring and fall	Very early spring; 5 to 10 pounds	Practically any soil type	Everywhere in the North; in region 2, winter and spring crop †
Ladino clover (*Trifolium repens var.*)	Sections 4*a*, 5*a*, and 5*b*	Very high	Spring to fall	Early spring; 5 to 10 pounds	Practically any well-drained, well-watered soil	Very productive but injured by heavy continuous grazing; danger of bloat

Least hop clover (*Trifolium dubium*)	Sections 2*a* and 5*a* and parts of 1*b*	High	Spring	Late summer; 4 to 5 pounds	Good soil	Annual, disappears in June, volunteers
Low hop clover (*Trifolium procumbens*)	Section 2*a* and southern part of section 1*b*	High	Spring	Late summer; 4 to 5 pounds	Practically any well-drained soil	Annual, usually disappears in June but volunteers
Sweet clover (*Melilotus alba* and *M. officianalis*)	Regions 1, 2, and 3; also section 4*a* where moisture is sufficient	Medium	Very early spring (2nd year) to late fall (1st year)	Winter and very early spring; 15 to 20 pounds	Any well-drained, non-acid soil	Nutritious pasture, but its success often requires applications of lime
Strawberry clover (*Trifolium fragiferum*)	Locally in sections 3*a*, 4*a*, and 5*a*	High	Spring to fall	Early spring; 5 to 10 pounds	Wet alkali soil	Grown only locally, domestic seed produced in Oregon
Sour clover or annual melilot (*Melitotus indica*)	Region 2 and sections 3*b*, 4*b*, and 5*b*	Medium	Winter and early spring	Late summer	Sweet well-drained soils	Annual, volunteers; no value north of region 2
Yellow trefoil or black medic (*Medicago lupulina*)	Region 2 and section 1*b*	Very high	Early spring to late fall	Very early spring; 8 to 12 pounds	Well-drained sweet soils	Not prominent, except on black land in Alabama and Mississippi
California bur clover (*Medicago hispida*)	Sections 3*b*, 4*b*, and 5*b* if sufficient moisture; also eastern Texas and Oklahoma	High	Fall to spring	Late summer; 15 to 20 pounds; hulled seed	Well-drained soils of practically any type	A winter annual; volunteers
Southern bur clover (*Medicago arabica*)	Region 2 and section 3*b*	High	Fall to spring	Late summer; 10 to 15 pounds; hulled seed	Well-drained soil	Winter annual, but reseeds
Common lespedeza (*Lespedeza striata*) ‡	Region 2 and section 1*b*	High	Early summer to fall	Early spring; 20 to 25 pounds	Well-drained soil	Annual, but is usually permanent in pastures because of volunteer seeding
Korean lespedeza (*Lespedeza stipulacea*)	Section 1*b*	High	Early summer to fall	Early spring; 20 to 25 pounds	Practically any well-drained soil	Annual, but volunteers

* By H. N. Vinall and C. R. Enlow, U.S.D.A.

† The region and section numbers refer to the map on page 439.

‡ Kobe and Tennessee 76 are heavy-yielding strains of common lespedeza which should be used in regions 2 and the southern part of section 1*b*.

On strongly acid soils red clover should be omitted from seed mixtures for pastures, and, from central Indiana south, lespedeza should be substituted for the clovers on such soils.

Bur Clover. This clover is used mostly for winter pasture in the South and the far West. In Arizona and California the

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White clover in permanent pastures adds nitrogen and humus to the soil and provides pasturage high in proteins, vitamins, and mineral salts.

burs and dry herbage are eaten in summer. In the South it succeeds very well with Bermuda or Dallis grass, as it furnishes grazing in fall, winter, and spring, and the grass furnishes summer grazing. It is advisable to graze bur clover lightly in May in order to allow it to reseed.

New seedings of bur clover should be inoculated if hulled seed is used, but generally sufficient soil adheres to the burs to carry inoculation if seeded in the bur.

The Low and Least Hop Clovers. These annual legumes are important in some parts of the South and the northern Pacific slope. They furnish early grazing but disappear in June. They

combine well with carpet, Dallis, and Bermuda grass, with lespedeza in the South, and with bluegrass and redtop in section 1*b*. Seed of *Trifolium dubium* is available in quantity, that of *T. procumbens* only in limited amounts in Tennessee.

Cluster Clover (*Trifolium glomeratum*). Cluster clover is a winter annual which has done well at McNeill, Mississippi, where it is called McNeill clover. The seeds germinate in the fall, and the plants grow rapidly in early spring so that grazing can begin in late February and last till June. Cluster clover fits in well, therefore, with Bermuda and carpet grasses and materially lengthens the grazing season.

Although experimental data are incomplete, there is reason to believe that cluster clover is not reliably hardy much farther north than the cut-over pine area in the Coastal Plains, and that its chief place will be on such lands in the southern half of region 2.

Persian Clover (*Trifolium resupinatum*). This winter annual is suited to moist rich land wherever winters are mild. Its value is still much in doubt since it has not shown any superiority over white clover, and in the sections where it thrives best white clover also does as well as a winter and early spring grazing crop. Persian clover makes its greatest growth about May, at which time it is high enough to cut for hay; soon afterward it matures seed and dies.

Ladino Clover. Where soil moisture is abundant ladino clover is one of the most productive pastures known, but it should not be grazed continuously, and there is considerable danger of bloat. Ladino is a giant strain of white clover from Italy; it was first established in the irrigated sections of the Northwest. In recent years it has become of great importance as a pasture and hay crop in New England, New York, and the northern Corn Belt states. When planted on bluegrass pastures or mixed with brome grass or orchard grass the losses from bloat are greatly reduced. It prefers a rich soil and on the poorer soils responds markedly to applications of phosphate fertilizer.

Sour Clover or Annual Melilot. This annual legume like lespedeza reseeds in pastures each year, and thus becomes more or less permanent. It is very sensitive to soil acidity, and therefore is found growing only on soils of limestone origin or those that are slightly acid. Its distribution is confined to our southernmost states, and it is of no value in the North.

Strawberry Clover. This is a perennial legume with about the same habit of growth as white Dutch clover. It is reported to be grown as a regular farm crop in Australia and New Zealand where it apparently thrives on excessively wet soils and yet is able to resist drought. Here in the United States it is grown only locally in sections 3*a*, 4*a*, and 5*a* and so far has not proved useful in the humid Eastern States. Its chief recommendation is its ability to grow on alkaline soils.

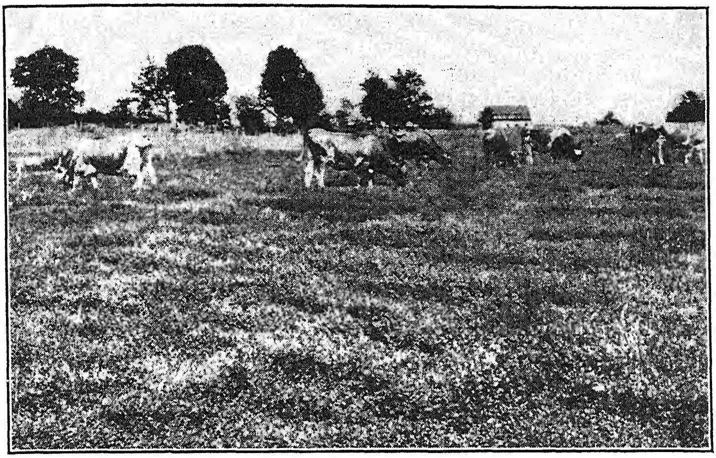
Yellow Trefoil or Black Medic. This winter annual is like the hop clovers, but is more widely distributed and usually makes a larger growth. It is most abundant on the black prairie soils of Alabama and Mississippi where it occasionally furnishes a considerable part of the pasturage in early spring. Its abundance varies greatly from year to year, and it cannot therefore be depended upon for grazing.

Common or Japan Lespedeza. This self-seeding annual is the most widely distributed of all lespedezas and is naturalized as far north as southern Iowa. Because of its ability to reseed under most conditions it is useful in pastures from southern Indiana and Illinois south to the Gulf of Mexico. It is a standard hay and pasture plant everywhere in section 1*b* and region 2, except on very sandy lands; even on sands it does fairly well, unless they are quite dry.

Kobe Lespedeza. Kobe is a variety of *Lespedeza striata* which makes a larger growth of stems and leaves than common lespedeza and has larger seed. It has about the same range of distribution as common lespedeza, but sometimes fails to reseed in section 1*b*. It is preferable to common lespedeza in region 2 on account of its higher yields of hay and pasture.

Like the common its growth is low and spreading except in thick stands.

Tennessee 76 Lespedeza. This selected strain of common lespedeza was originated by the Tennessee Agricultural Experiment Station. It is characterized by an erect growth, heavy yields of hay, and rather late maturity. It is most



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Lespedeza furnishes excellent pasturage for dairy cattle.

popular in western Tennessee and parts of North Carolina. It should succeed throughout region 2 also, but authentic seed of Tennessee 76 is rather difficult to obtain in quantity. The seed of this variety is not distinguishable from that of common lespedeza.

Korean Lespedeza. This variety is an annual also, but it belongs to a different species from common lespedeza. It is earlier, coarser, and usually a heavier producer than common, but its production is ordinarily less than that of Kobe or Tennessee 76 in localities where these two varieties are grown successfully. Korean is of most value in section 1*b* but promises to be successful in some parts of 1*a* as far north as

southern Michigan. In the southern part of section 1*b* its early maturity is of some disadvantage, as there are usually 30 days or more of grazing weather after Korean matures.

SUGGESTIONS

1. In spring and fall make a pasture and meadow trip. Study condition of local pastures and meadows. What grasses come earliest in spring? What grasses furnish the best fall pasture? Summer pasture? Note leading weeds. Which pastures are weediest, those well stocked or those partially grazed? Draw conclusion.

2. Ask farmers about seeding mixtures for meadows and pastures, time of planting, methods, and rates. What mixtures are planted on various soil types? What mixtures are recommended by your agricultural experiment station?

3. Do farmers in your locality apply lime and fertilizers when seeding pasture and meadow crops? What quantities are used per acre? Are lime and fertilizers applied as top dressings on permanent pastures and meadows? How much per acre? What applications of lime and fertilizer are recommended by your experiment station for pasture and hay crops?

4. Secure samples of hay from mows in your neighborhood. Note color, odor, comparative leafiness and stemminess, percentage of weeds present. Grade according to United States grades, as secured from nearest hay dealer or Bureau of Markets, U.S.D.A.

5. Visit haymows and haystacks in your neighborhood. How many farmers have (1) clover hay, (2) alfalfa hay, (3) mixed hay, (4) timothy hay, (5) wild hay? Notice condition of dairy cattle fed on (1) alfalfa or clover hay and (2) timothy or mixed hay. Get full grain or concentrated feed ration fed with (1) alfalfa or clover, (2) timothy or mixed hay. Compare.

6. Notice quality of hay in each mow; color, odor, freedom from weeds, dustiness, whether stemmy or leafy. Find out stage of maturity at which each lot was cut for hay and how it was handled in the field. Determine which farmer has the best hay, from standpoint of leafiness, color, and palatability. How does he make and store his hay?

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CHAPTER XXVIII

MANAGING PASTURES

From the standpoint of efficiency in agricultural production, it is agreed that the maintenance of a generally increasing proportion of the acreage of cultivated land devoted to permanent pasture, or to pasture grasses in rotation, not only will maintain and improve fertility, but also will cheapen the cost of producing meat and milk. Cultivated crops and green crops, following pastures in rotation, or a recently plowed permanent pasture, produce greatly increased yields per acre. As a general rule the proper use of pastures reduces production costs and increases the net gains per farm.

Although great progress has been made in the improvement of our pasture management and nearly all state experiment stations as well as the federal government have issued recent publications in regard to the improvement and use of pastures, nevertheless the field is one that offers great opportunity for further development. Pastures and meadows must be made more productive by growing the best-adapted grasses and legumes; by properly fitting of seed beds when new pastures are established; by applying lime, phosphate, and other fertilizers, as needed; by preventing overgrazing of pastures and ranges; and by controlling weeds.

Improve Quality of Grass by Use of Lime and Fertilizers. As a general rule, the health of livestock and poultry is improved by the use of pastures, and it is now known that there is a definite relationship between the mineral and vitamin content of grasses and the fertility of soil, either natural fertility or fertility resulting from the application of mineral elements, nitrates, and lime. It is known also that our meat-producing

and milk-producing animals, fed on grasses high in minerals and vitamins, produce products for human consumption higher in these elements so vital to health.

The United States Department of Agriculture issued the following statement on October 14, 1936:

Richer soil in pastures makes richer feed for the animals. By applying fertilizers to pasture soils it is possible, in some cases at least, to improve the quality and feed value of the grass plants as well as to increase the yield. This is the result of experiments at the Beltsville Research Center, as reported by H. N. Vinall and H. L. Wilkins of the Bureau of Plant Industry, U. S. Department of Agriculture. The results run counter to a generally held opinion that the application of minerals to the soil will not increase the percentage of minerals in a purely grass herbage.

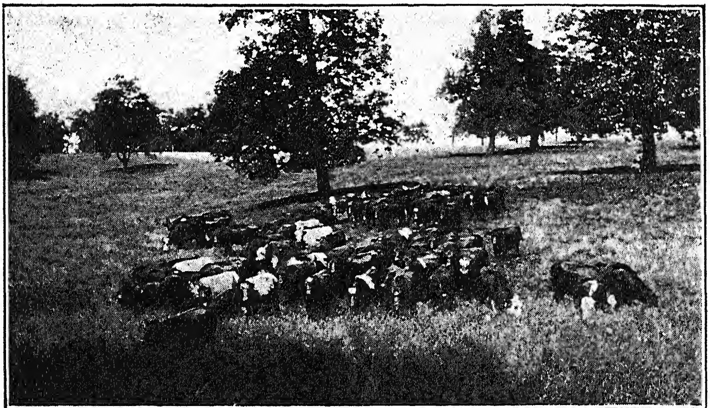
Livestock men have long known that there is a difference in the nutritive value of grasses growing on different soils and in different sections of the country. The bluegrass pastures of Kentucky are noted for the fine quality of animals that grow in the region.

More recently it has been recognized that in several parts of the United States there is actual malnutrition of grazing animals, that the animals do not get from the grass enough of all the kinds of feed materials that they require. The most common deficiency is a shortage of phosphorus. Animals that do not get enough phosphorus on pasture try to make up the deficiency by chewing decaying and weathered bones. In some parts of Florida there is a disease of range cattle known as "salt sick" which has been traced to a deficiency of iron and copper in herbage.

In the Beltsville experiments, Vinall and Wilkins grew pure stands of grasses and clovers on small plots of rather poor soil, and also on the same soil enriched with various combinations of nitrogen and phosphorus fertilizers. They analyzed the grasses clipped from the plots and found that on Kentucky bluegrass nitrogen applied in the fertilizer increased the crude protein in the herbage 12.34 per cent; phosphorus applied in fertilizer increased the phosphorus in the herbage 25.64 per cent and resulted in an increase of 16.67 per cent in the calcium content of the herbage. Evidently an ade-

quate supply of available phosphorus enables the plant to utilize larger quantities of calcium.

The results with white clover differed somewhat from those with Kentucky bluegrass. Nitrogen applications did not increase the percentage of protein in the clover and there was a significant decrease in calcium where nitrogen was applied. Phosphorus in the



Kentucky Exp. Sta.

The permanent bluegrass pastures of the limestone soils of Kentucky, Tennessee, and Virginia are famous for the efficient feeding of horses, sheep, and cattle.

fertilizer, however, increased the phosphorus content of the clover 22.22 per cent and the calcium content 11.9 per cent.

The proper use of pastures not only improves the crop management program of the average individual farm but also is of basic importance in our National Agricultural Conservation Program. The program is addressed to the control of erosion and the building up of our soil fertility in order to maintain our great heritage of splendid land and to provide coming generations of America with an assured supply of food and clothing from the land.

The Kinds of Pastures. Lands that were once cultivated and that have been seeded with, and are now planted to, do-

mesticated pasture plants and used for grazing livestock are classed as tame pastures, of which there are four main types.

Permanent pastures are grazing lands occupied by perennial pasture plants, the annuals that self-seed, or both, and remain unplowed for long periods.

Rotation pastures form a unit in a crop-rotation plan and are plowed within a five-year or shorter interval.

Supplemental or temporary pastures are fields used to supplement the rotation pastures at times when they do not provide enough pasturage for the livestock on the farm. Supplemental pastures are usually provided by seeding Sudan grass, lespedeza, small grains, or other annuals for pasture; or by planting soybeans or sweet clover for pasture purposes.

Annual pastures are seeded each year to supplement permanent pastures. The more important annual pasture plants are winter rye, Sudan grass, soybeans, lespedeza, oats, barley, rape, and vetch.

Natural or native pastures are lands in their native state or uncultivated, occupied by natural grasses and legumes. The Western ranges represent extensive natural pastures under conditions of limited rainfall. Brush and woodland pastures and cut-over pastures produce good pastures from native grasses in the humid regions. In the Great Lakes Region and in the Southern States, large areas of swale grasses furnish much native pasture.

Choosing the Best Adapted Pasture Crops. In seeding pastures, it is highly important that the seed of crops best adapted to the soil and climatic condition be used. Both grasses and legumes vary greatly in their ability to thrive on sandy, muck, or clay soil, under wet and dry soil conditions, and in their susceptibility to soil acidity, or to conditions of shade, and so on.

Professor W. L. Burlison of the University of Illinois presents the following classification of forage crops adapted to indicated soil conditions and climate (*Circular* 465, Illinois Experiment Station):

Drought-Resistant

- Brome grass
- Tall oat grass
- Wheat grasses
- Lespedeza
- Sweet clover
- Alfalfa

Tolerant to Shade

- Orchard grass
- Rough-stalk meadow grass
- Wood meadow grass
- Meadow fescue
- Red fescue
- Chewing's fescue
- White clover (slight tolerance)

Hot Weather Required

- Sorghums
- Sudan grass
- Bermuda grass
- Soybeans
- Cowpeas
- Lespedeza

Cool Weather Required

- Kentucky bluegrass
- Canada bluegrass
- Timothy
- Brome grass
- Wheat grasses
- Field peas
- Winter vetch
- Red clover
- Alsike clover
- Crimson clover

Rich Soil Required

- Kentucky bluegrass
- Timothy
- Brome grass
- Meadow fescue
- Perennial rye grass
- Creeping bentgrass
- Alfalfa
- Red clover
- Alsike clover
- White clover

Tolerant to Poor Soil

- Orchard grass
- Canada bluegrass
- Tall oat grass
- Red fescue
- Chewing's fescue
- Redtop
- Rhode Island bentgrass
- Sheep fescue
- Lespedeza
- Sweet clover } tolerant if soil
- Mammoth clover } is sweet

Tolerant to Sandy Soil

- Brome grass
- Italian rye grass
- Tall oat grass
- Canada bluegrass
- Meadow foxtail } tolerant if
- Reed canary grass } soil is wet
- Redtop

Tolerant to Wet Soil

- Reed canary grass
- Timothy
- Meadow foxtail
- Meadow fescue
- Canada bluegrass
- Rough-stalk meadow grass
- Redtop

Tolerant to Sandy Soil (Cont.)

Red fescue
Rhode Island bentgrass
Sheep fescue
Bermuda grass
Alfalfa
Winter vetch
Cowpeas

Tolerant to Wet Soil (Cont.)

Creeping bentgrass
Fowl meadow grass
Alsike clover

Plant Right Mixture for Your Soil Region. It is general to mix grasses and legumes in establishing permanent pastures. The advantages of adapted grasses and legume mixtures are set forth as follows by the United States Department of Agriculture in *Miscellaneous Publication* 194, "A Pasture Handbook":

It is seldom advisable to seed land intended for a permanent pasture to one grazing plant. A mixture of several kinds, especially of grasses and legumes, has many advantages, among which may be mentioned the following:

(1) Legumes in pasture mixtures help to maintain the nitrogen content of the soil and reduce the need of nitrogen fertilizers.

(2) Mixtures result in a more uniform stand and higher production, because several soil conditions are often represented in a pasture, and in a mixture plants adapted to each soil condition are likely to be found.

(3) Mixtures provide a more uniform seasonal production because the periods of flush growth and dormancy vary in different plants.

(4) Mixtures of grasses and legumes provide a better-balanced ration, since legumes are richer than grasses in both protein and minerals.

(5) Soil temperatures are lower during summer months under mixed seedings of grasses and legumes, greatly increasing the growth of the grasses.

The following mixtures are recommended for each section of the United States where permanent pastures of the highest productivity are desired. The cost of the necessary seed may seem an extravagance, but this investment is usually returned within the first two years because of the higher productivity of pastures thus seeded.

Northeastern States
(Section 1*a* in map, page 439)

Good, Well-Drained Soils

Mixture	Pounds per Acre
Kentucky bluegrass.........	5 or 6
Orchard grass..............	4 or 5
Timothy..................	4 or 5
Redtop....................	2 or 3
Alsike clover...............	2 or 2
Red clover.................	2 or 2
White clover...............	1 or 2
Total.................	20 or 25

Poor, Well-Drained Soils

Mixture	Pounds per Acre
Orchard grass..............	8 or 10
Canada bluegrass...........	5 or 6
Redtop....................	4 or 5
Alsike clover...............	2 or 3
White clover...............	1 or 1
Total.................	20 or 25

In Iowa, Minnesota, and the Dakotas, brome grass may be substituted for orchard grass in these mixtures, and Reed canary grass alone makes a very productive pasture where rainfall conditions are favorable.

Wet, Poorly Drained Soils

Mixture	Pounds per Acre
Timothy..................	4 or 6
Redtop....................	8 or 10
Alsike clover...............	3 or 4
Total.................	15 or 20

Mixture	Pounds per Acre
Reed canary grass..........	5 or 8
Redtop....................	4 or 4
Alsike clover...............	1 or 3
Total.................	10 or 15

Reed canary grass may be sown alone at the rate of 8 to 12 pounds per acre on land likely to be submerged for a part of the year, and excellent pasture obtained thus from land otherwise unproductive.

Eastern Central States

(Section 1*b* in map, page 439)

Good, Well-Drained Soils

Mixture	Pounds per Acre
Kentucky bluegrass	5 or 6
Orchard grass	4 or 5
Timothy	2 or 3
Redtop	2 or 2
Lespedeza	6 or 7
White clover	1 or 2
Total	20 or 25

Poor, Well-Drained Soils

Mixture	Pounds per Acre
Orchard grass	5 or 6
Tall oat grass	4 or 5
Redtop	4 or 5
Lespedeza	7 or 9
Total	20 or 25

Wet, Poorly Drained Soils

Mixture	Pounds per Acre
Timothy	5 or 6
Redtop	8 or 10
Alsike clover	3 or 4
Total	16 or 20

Mixture	Pounds per Acre
Meadow foxtail	4 or 5
Redtop	8 or 10
Alsike clover	4 or 5
Total	16 or 20

In the northern part of this section the Korean lespedeza should be used; in the southern part, common, Kobe, or Tennessee 76 are best. The latter two varieties are usually more productive than the common, but good results are obtained from a mixture of common and Korean in Tennessee and North Carolina.

Southeastern States
(Region 2 in map, page 439)

Moist, Sandy Soils

Mixture	Pounds per Acre
Carpet grass	5 or 6
Dallis grass	3 or 4
Lespedeza	12 or 15
Total	20 or 25

Clay, Loam, or Clay or Silt-Loam Soils

Mixture	Pounds per Acre
Bermuda grass	5 or 6
Dallis grass	3 or 4
Lespedeza	10 or 12
White clover	2 or 3
Total	20 or 25

Common, Kobe, and Tennessee 76 lespedezas are the varieties to use in Region 2. Bermuda grass is usually started by planting pieces of sod rather than seed.

Great Plains and Intermountain Regions
(Regions 3 and 4)

In the Great Plains (Region 3) and in the Intermountain regions (Region 4) the climate varies from semi-arid to arid or desert conditions, and pastures are chiefly extensive areas of ranges occupied by native grasses, legumes, woody shrubs, and other plants of some value for grazing. This is true with two exceptions, the irrigated districts and the mountain valleys at high altitudes. In the Great Plains the herbage consists mostly of "short grasses," such as the gramas, buffalo, and mesquite grasses, whereas in the

Intermountain region bunch grasses and desert shrubs predominate at the lower altitudes. This native flora is the main source of pasturage, and proper methods of grazing designed to protect and encourage the most valuable grazing plants are more important than the improvement of grazing conditions by seeding tame or introduced plants.

In the northern parts of these areas (Sections 3*a* and 4*a*), when it is desired to restore to grazing condition land that has been cultivated, crested wheat grass, brome grass, or slender wheat grass may be seeded in localities that are favorably situated as to rainfall. All are drought-resistant, nutritious, and palatable. Their value for grazing is about in the order named. Mixtures of slender wheat grass and sweet clover are also recommended.

The productiveness of pastures in the high mountain valleys may be increased by seeding timothy, redtop, Kentucky or Canada bluegrass, meadow foxtail, and red, alsike, and white clovers, alone or in mixtures. Crested wheat grass, brome grass, and slender wheat grass will also thrive under these conditions.

Northern Part of Regions 3 and 4
(Map on page 439)

For Irrigated Lands

Morton's Mixture (Modified)	Pounds per Acre
Smooth brome grass	9
Orchard grass	9
Timothy	4
Meadow fescue	5
Yellow sweet clover	3
Total	30

Montana Mixture	Pounds per Acre
Smooth brome grass	3 or 4
Kentucky bluegrass	4 or 6
Orchard grass	4 or 6
Meadow fescue	3 or 4
White clover	1 or 2
Alsike clover	1 or 2
Total	16 or 24

Alfalfa or sweet clover seeded alone at the rate of 12 to 15 pounds per acre is used by many farmers on the irrigation projects with good results where care is observed to prevent bloating. The mixtures and also the legume pastures on well-drained soils ordinarily have a carrying capacity of two or more animal units per acre for 4 to 6 months, depending upon the latitude.

On wet or poorly drained soils a mixture consisting of redtop, 10 pounds, timothy, 6 pounds, and alsike clover, 4 pounds, ordinarily gives the best results.

In the South (Sections 3*b* and 4*b*) the pastures on irrigated lands are largely either Bermuda grass or alfalfa. Dallis grass, another perennial, is adapted to these two sections and makes a more productive pasture on irrigated lands than Bermuda grass.

Northern Pacific Slope
(Section 5*a* in map, page 439)

On the Pacific slope in Section 5*a*, where rainfall is fairly abundant, especially during the winter season, the rye grasses and bents thrive, and rather complicated mixtures are recommended.

The principal disadvantage in using seaside bent, meadow foxtail, or Reed canary grass is in the excessive cost of the seed.

On irrigated lands in Section 5*a* the mixture recommended for moist bottomland is perhaps the best pasture for irrigated lands.

For Moist Bottomland

Mixture	Pounds per Acre
Italian rye grass	3
Perennial rye grass	3
Meadow fescue	4
Kentucky bluegrass	4
White clover	2
Red clover	2
Alsike clover	2
Total	20

For Fertile Uplands

Mixture	Pounds per Acre
Italian rye grass	4
Tall oat grass	4
Orchard grass	4
Kentucky bluegrass	4
White clover	2
Red clover	2
Alsike clover	2
Total	22

For Land Subject to Flooding for Short Periods

Mixture	Pounds per Acre
Seaside bent	5
Meadow foxtail	5
Italian rye grass	4
Alsike clover	4
Total	18

For Land Subject to Flooding for Long Periods

	Pounds per Acre
Reed canary grass	8 to 12
or	
Seaside bent	8 to 10

Both alfalfa and ladino clover seeded alone have been found to make unusually productive pastures for dairy cattle. There is, however, grave danger of losing some of the animals from bloating when either of these legumes is grazed.

In the southern part of the Pacific slope in Section 5*b* the summers are quite dry and the rainfall during the winter is light so that natural pastures consist largely of winter annuals which reseed each year. On the irrigated lands a large part of the pastur-

age is obtained from alfalfa fields. Ladino clover, Bermuda grass, and Dallis grass also do well here.

Southern Pacific Slope
(Section 5b in map, page 439)

Irrigated Lands

Mixture	Pounds per Acre
Dallis grass	5
Italian rye grass	5
Alfalfa	5
Ladino clover	6

This mixture, requiring a total of 21 pounds per acre, is seeded in the spring. Such a pasture is much less likely to cause bloating than alfalfa or ladino clover alone; and it provides a longer grazing season and a better balanced ration, makes better use of the irrigation water, and is less expensive to maintain. Harding grass, sweet clover, and orchard grass are sometimes added to this mixture, but the simpler one as given is on the whole more satisfactory.

The New York Pasture Program. In developing a pasture program, Cornell University has, in cooperation with New York farmers, established a program of procedure adapted to conditions in New York State and to similar conditions in other states. The basic principles underlying the New York Pasture Program are summarized as follows by Professor D. B. Johnstone-Wallace, of the Department of Agronomy, Cornell University:

1. *The Type of Pasture to Improve*
   Improve the best pasture land on the farm.
2. *The Area of Pasture to Improve*
   Improve one acre of pasture for each cow or its equivalent to be maintained on the farm.
3. *The Cost of Pasture Improvement*
   The annual cost of a sound pasture-improvement program need not exceed $2 a year for each acre improved or for each cow or its equivalent maintained on the farm.

Darling, U.S.D.A. Farmers' Bul. 1759

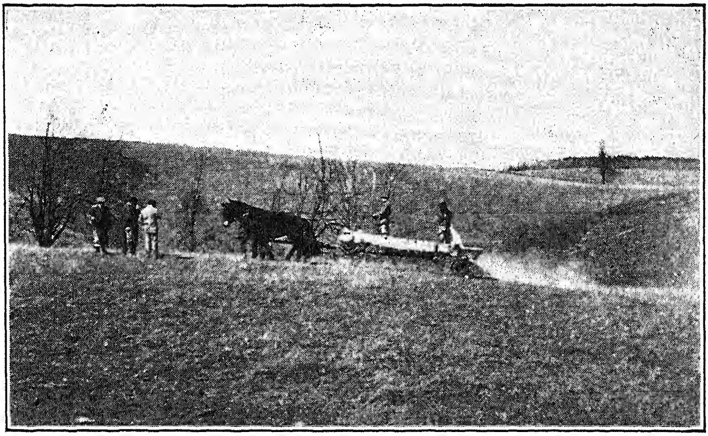
Gullies filled with soil-conserving plants and protected by adapted grasses provide pasture for livestock and protection and feed for wild life.

4. *Supplying Phosphorus*

Available phosphorus is the first essential in the improvement of New York pastures. Apply to all pastures to be improved, preferably in the fall, 800 pounds of 16 per cent superphosphate or its equivalent per acre and repeat at intervals of about 4 years.

5. *Supplying Lime*

An application of lime sufficient to permit the growth of red clover is desirable, especially when the limestone requirement for red clover is greater than 2000 pounds per acre or when the *p*H is less than 5.5.



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Applications of lime and fertilizer applied as a top dressing greatly increase yields of old pastures and meadows.

6. *Supplying Potash*

Light sandy and gravelly soils may require an application of about 100 pounds of muriate of potash per acre at intervals of about 4 years. Heavier soils seldom respond to potash.

7. *Supplying Nitrogen*

Nitrogen is as important as phosphorus in pasture improvement. The nitrogen required is best obtained through pasture legumes, especially wild white clover.

Pastures containing an average of less than one plant of wild white clover to the square yard, evenly distributed, should be seeded with 1 pound of wild white clover to the acre in early April, or they may be plowed, fertilized, and seeded with the Cornell Pasture Mixture.

8. *Pasture Management*

   Grazing management is as important as fertilization in pasture improvement. The following rules should be observed:

   a. *How to Graze*

      Stock pastures sufficiently heavily to prevent herbage from exceeding an average of 4 inches in height at any time.

   b. *When to Start Grazing*

      Stock pastures when a growth of about 3 inches has been made and when the ground is dry enough to carry stock without excess injury to the turf. In New York State this usually means early in May.

   c. *When to Stop Grazing*

      Remove stock from closely grazed pastures sufficiently early to permit a growth of about 3 inches to be made before winter arrives. In New York State this usually means early in October.

   d. *Alternate Grazing*

      As an aid to good grazing management, divide the pasture area into about 4 fields each with independent access to water and graze these in sequence.

   e. *Mowing*

      Mow pastures very closely once or more during the grazing season, particularly at the end of the peak period of growth in June.

   f. *Harrowing*

      Heavily stocked pastures should have cattle droppings scattered once or more during the grazing season, particularly in September.

   g. *Rolling*

      Roll pastures with a smooth roller in April or early May to reduce damage done by winter heaving and to facilitate close mowing and even grazing.

9. *Draining Pastures*

   Open up existing water courses and drain excessively wet spots in pastures.

10. *Establishing New Pastures*

    a. Prepare seed bed by plowing or harrowing.

b. Fertilize as for old pastures.
c. Seed in April or May, preferably without a nurse crop.
d. Control weeds by mowing until July, then graze until September in year of seeding, if sufficient growth has been made.
e. Use the following mixture:

CORNELL PASTURE MIXTURE FOR 1937

	Pounds per Acre
Kentucky bluegrass	10
Canada bluegrass	2
Rough-stalked meadow grass	1
Timothy (preferably Aberystwyth pasture timothy No. *S*50)	6
Perennial rye grass (preferably Svalof Victoria)	5
Wild white clover (preferably Kent old pasture)	1
	25

11. *Establishing Meadows Suitable for Aftermath Grazing*
Add one to two pounds of wild white clover, ladino white clover, or yellow trefoil to the meadow mixture used if provision can be made for aftermath grazing.
12. *Establishing Long Term Meadows to be Used for Hay and Pasture*
Use the following mixture:

CORNELL HAY-PASTURE MIXTURE FOR 1937

	Pounds per Acre
Timothy (preferably Cornell 1777)	6
Red clover	2
Alsike	2
Perennial rye grass (preferably Svalof Victoria)	4
Kentucky bluegrass	2
Canada bluegrass	2
Rough-stalked meadow grass	1
Yellow trefoil	2
Wild white clover (preferably Kent old pasture)	1
	22

13. *Supplementary Feeding on Pastures*
Meadow aftermath, hay, silage, alfalfa, Sudan grass, and other special crops may be used to supplement pastures, especially during July and August. Concentrates will be required by high-yielding cows even on good pasture. The allowance of concentrates should be varied with the condition of the pasture as well as with the milk yield. Because of the high protein content of improved and well-grazed pasture, concentrates high in protein are unnecessary.

14. *Supplementary Minerals on Unimproved Pastures*
Improved pastures supply sufficient minerals, but stock grazing unimproved poor pastures should be allowed access to a mineral mixture consisting of bone meal, 40 per cent, ground limestone, 40 per cent, and salt, 20 per cent.

Pasture Improvement in New Jersey.[1]

If possible, apply a dressing of manure to at least one-third of the pasture yearly, so that the entire pasture is treated once in three years. Manure may be spread during the fall, winter, or early spring.

Apply sufficient lime to correct excessive acidity. On strongly acid soils, it may prove necessary to lime several months or a year in advance to permit response from phosphate fertilizers.

Apply 10 to 12 tons of manure in winter or early spring, once every two years. The first growth after manuring may be cut for early hay about May 25, and the field grazed thereafter.

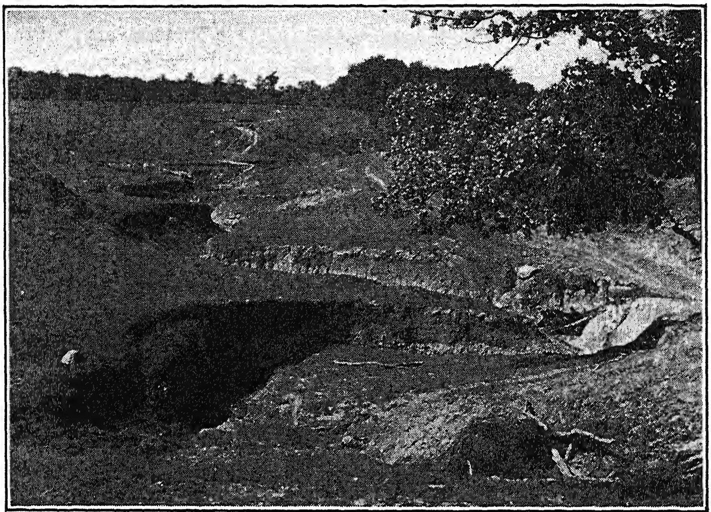
Apply mineral fertilizers to fields once in two years, alternating with manure if it is available. Broadcasting 400 pounds of superphosphate and 100 pounds of muriate of potash per acre will increase the abundance of clover and grass and provide greater drought resistance. On questionable soils, treatment of a small area with phosphates to determine whether response to this material depends on liming should precede general application of such fertilizer.

Apply lime, phosphate, and potash fertilizers to all fields once every 2 or 3 years.

[1] As recommended by Howard B. Sprague, Agronomist, New Jersey Agricultural Experimental Station.

Treat 1 or 2 fields (depending on the total number) with manure, to be cut for young hay about June 1 and grazed in rotation with other fields thereafter.

Treat one field with 300 pounds per acre of sulfate of ammonia (or its equivalent) in late March, and a second field similarly about two weeks later. Apply 200 pounds per acre of additional nitrogen



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A specific enterprise in gully control and pasture improvement is needed in the above field.

fertilizer to one of these pastures in early June, provided the soil type has strong water-supplying power.

Apply the nitrogen fertilizer and manure to different fields in succeeding years.

Lime and manure used together have been profitable treatments for pastures on a variety of soil types in this state. Eight to ten tons of manure and one-third to two-thirds of a ton of hydrated lime per acre, applied once in 3 years, actually increased feed yields 30 to 45 per cent for the following 3 seasons.

Under conditions that permit response to phosphate and potash fertilizers the application of about 600 pounds of superphosphate

and 100 pounds of muriate of potash, once in 2 or 3 years, may be expected to improve total herbage yields by stimulating growth earlier in spring and later in fall, and also by substantially improving the feed yields in the dry months of July and August. In addition, such fertilizers frequently increase the abundance of clover, which is not only relished by livestock, but is also rich in the minerals needed by animals.

Lime is one of the most important soil-improving materials, since full returns are not obtained from either manure or fertilizers without it. Lime is slow in action and therefore should be applied some time in advance of commercial fertilizers. Winter and early spring are favorable seasons for this treatment since freezing and thawing of the soil aids in its penetration. The quantity of lime required varies with the soil type. However, addition of 1 ton of finely ground limestone, or two-thirds of a ton of hydrated lime, per acre, may prove sufficient on more acid types, and one-half to one-third as much on less acid soils.

Eight to ten tons of manure per acre, applied in winter or early spring, is an excellent treatment to accompany liming. In case fresh manure is used, it may be desirable to cut the manured fields for early hay in June, and pasture them thereafter. Such hay is of high quality, and the succeeding growth is grazed readily.

A single application of lime and manure, applied in early spring of one year, increased yields of herbage 31 to 47 per cent for the 3 following seasons, in actual experiments conducted on three widely different soil types in the state. At present prices, the increased feed obtained per acre of pasture treated in this fashion would have a value of $61.90 if purchased. Nitrogen fertilizers applied in March or April make the most satisfactory returns on sod land that is well supplied with lime, phosphate, and potash. One acre of pasture sod, properly fertilized, will care for 6 to 8 cows during the 3 weeks prior to grazing of untreated pastures. A light application of potash also yields rich returns on certain soil types. Fall applications of lime and minerals are desirable since the freezing and thawing aids in their penetration into the soil.

Experiments conducted by the Agronomy Department of the New Jersey Agricultural Experiment Station, including 24 types of pasture fertilization, on 3 soils over a period of 3 years, have shown that both yield and quality of pasture may frequently be improved

with small cost. The most profitable treatment on Chester gravelly loam, for instance, was one-third ton hydrated lime, 600 pounds superphosphate, and 100 pounds muriate of potash per acre, applied once in 3 years. The addition of these materials to an established sod in early spring increased the average yield of feed for the following 3 seasons 79.4 per cent as compared with the untreated pasture, and 63.0 per cent in comparison with lime plus 75 pounds of sulphate of ammonia yearly. The combination of lime and phosphate increased yields 49.4 per cent; whereas lime, phosphate, and 10 tons of manure applied once in 3 years produced 66.4 per cent more feed.

Pasture Improvement in Indiana.[2]

Heavily pastured soils respond particularly to phosphorus and nitrogen and in some cases to potassium as well. Many have become acid enough to need lime. On soils testing acid, an application of one ton of ground limestone per acre, or its equivalent in some other form of lime, should prove adequate. It may be applied at the farmer's convenience as a top dressing, although preferably some months before any application of phosphorus. Limestone works down slowly into the soil unless cultivated in, but even as a top dressing it encourages the growth of legumes and the better grasses.

Commercial nitrogen in addition to superphosphate, applied at the rate of 150 to 200 pounds per acre as soon as growth starts in the spring, will advance grazing from one to two weeks. To avoid burning the tender leaves, apply when the pasture is dry.

Superphosphate (acid phosphate) is the first fertilizer material to use and the one most likely to pay through stimulation of both legumes and grasses. Application of 300 to 500 pounds of 20 per cent superphosphate per acre, or its equivalent, is recommended and should last from three to five years.

Barnyard manure is an excellent top-dressing for pasture except where it carries a lot of weed seeds. When applied at the rate of 4 to 8 tons per acre it adds considerable nitrogen. Pasture land is the logical place to apply any surplus manure after the crops in the rotation are manured. As manure is relatively low in phos-

[2] As recommended in *Extension Bulletin* 205, April, 1935.

phorus it is a good practice to add superphosphate to the manured land at half the rates per acre recommended above.

Under conditions where very few desirable pasture plants remain it may be better to plow, fertilize, and reseed the land with an adapted pasture mixture than to depend upon fertilizers alone for rejuvenation.

Reseeding Treatments Recommended

Loam and silt-loam soils that are well drained are best for permanent pastures. Such soils that were once productive will give excellent response to fertility treatment, and in some cases reseeding with better adapted mixtures may prove helpful. Water-logged or strongly acid soils produce poor pastures, both in quantity and quality. Neither reseeding nor fertility treatments will be of much benefit on such soils until they are drained or limed. Soils which are sandy, gravelly, or shallow due to underlying rock or shale are subject to drouth and hence poorly adapted to grasses and most legumes. Little if any expense is justified on these soils except possibly a light reseeding of better adapted grasses or legumes.

One way of strengthening a thin pasture is to reduce the number of animals grazed or allow the pasture to get a better start in the spring. Grass which is kept closely cropped from the time growth begins is greatly weakened because of reduced food reserves stored in the underground parts. Until this condition is corrected the grass will make little recovery. Rye provides a very early spring pasture which allows permanent pasture to get well started and the sod to become well settled before grazing starts.

Reseeding a run-down pasture is rarely effective unless soil deficiencies are corrected through the use of lime, fertilizer, or manure. Demonstrations in Indiana and experiments in other states show that the use of fertilizer or fertilizer and lime, as needed, will thicken a thin sod in a short time without expense for cultivation or reseeding. The exception to this is where the desirable pasture plants have practically disappeared and must be reestablished by cultivation, fertilization, and reseeding.

Usually it is advisable to start a pasture by sowing the seed with a light seeding of a small-grain nurse crop on a firm, finely prepared seed bed. Grasses should be sown preferably in the early fall and legumes in the spring, although grasses may be sown at either

time. Three hundred to 500 pounds per acre of a 2–12–6 fertilizer or manure will be helpful in establishing a pasture on most soils. If the soil tests acid, and lime-loving grasses and clovers are desired, two or three tons of ground limestone should be applied per acre, depending upon the degree of acidity.

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During recent years alfalfa has achieved a place as a leading pasture crop for dairy cattle and livestock in general.

Drilling the seed shallow gives a more even distribution and covering, requires less seed, and results in a more even stand than broadcasting. If seed does not work well in the drill, it should be broadcast and covered with a cultipacker or with a spike-tooth harrow set shallow.

Nebraska's Pasture Contest. Beginning in 1935, Professors P. H. Stewart and E. F. Frolik of the Nebraska Agricultural College instituted a Pasture Contest in which several hundred farmers have cooperated annually.

The following statement of a competitor in the contest gives an idea of how this new method of state-wide pasture improvement works.

My Pasture Plans and Practices

By Lawrence Quante, Brock, Neb.

There are four main objectives in planning a pasture program, to wit: (1) to provide early pasture; (2) to provide a mid-summer pasture; (3) to provide pasture late into the fall; and (4) to provide a lot of pasture per acre all of the time.

On this farm, temporary pastures are used extensively. The pasture set-up in 1936 consisted of the following fields:

1. Fall-seeded rye for early spring pasture.
2. Oats and first-year sweet clover to fill in the gap between rye and sudan grass.
3. Sudan for hot-weather pasture.
4. Permanent alfalfa-grass pasture when needed.

The permanent pasture in this set-up came into usage following the 1934 drought during which the regular bluegrass pastures were "killed out." It was an old alfalfa field, about one-half killed out, part of which was plowed and part disked in the fall of 1935. The entire field was seeded to a mixture of orchard grass, rye grass, bluegrass and brome grass. The disked portion turned out best and this fall had a good stand of alfalfa and brome grass with some orchard grass and bluegrass. It was pastured lightly all summer with no bloat difficulties.

Sudan grass was planted on corn stalk ground, plowed early and left rough to catch early spring rains. Although the summer was very dry, the Sudan produced continuous pasturage. No trouble with prussic acid poisoning was encountered.

Because the sweet clover seeded this spring perished during the summer, a new field was seeded this fall to provide second-year sweet clover in 1937. A little wheat was included to curtail bloating. Also an alfalfa-brome-bluegrass seeding was made this fall, to be used for hay at first and later for pasture.

State-wide Pasture Contests are being conducted in other states where pasture improvement is of great importance.

SUGGESTIONS

1. Secure from your state college of agriculture the bulletins dealing with the management of pastures.
2. Plan specific programs of pasture management and improvement for home farms.
3. Visit experiment stations or farms carrying on pasture improvement demonstrations.
4. Plan for some pasture improvement demonstrations to be carried on in the local community.

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CHAPTER XXIX

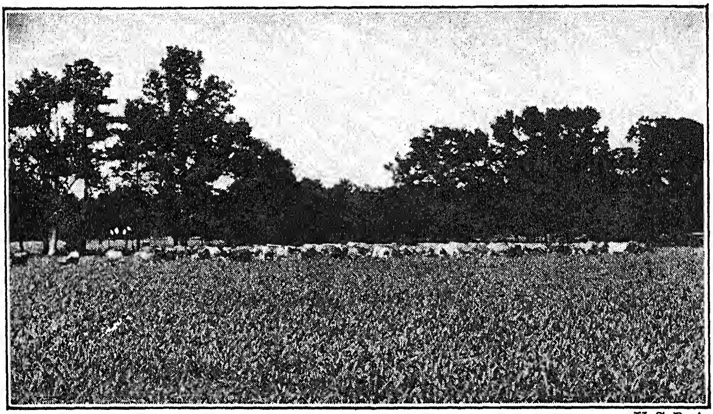
GROWING ANNUAL GRASSES AND LEGUMES FOR HAY, PASTURE, GREEN-MANURING, AND COVER-CROP PURPOSES

When drought, severe winter, or other causes reduce the yields of pasture and meadow crops, it is frequently necessary to plant quick-growing annual crops that will furnish abundance of hay and pasture. Extreme floods or severe frosts in late spring or early summer or insect damage may cause the loss of the corn crop and other forage crops. Emergency crops that can be planted late in the season and that will produce an abundance of feed must be depended upon. Additional pasture is often needed on the average farm to supplement bluegrass pasture when its growth is dormant during hot dry spells after mid-summer. There is frequent need of quick-growing crops that will provide cover and prevent erosion and supply the soil with an abundance of humus. For all these purposes, as emergency crops, supplementary pasture, hay crops, and green-manuring and cover crops, the following grasses and legumes are important.

Sudan Grass. During recent years Sudan grass has largely supplanted millet as an annual hay and pasture grass in the lower two-thirds of the United States, and its use in the Northern States has grown rapidly, particularly for feeding dairy cows. This crop was discovered and introduced into the United States by the Department of Agriculture in 1909. A warm-weather crop and notably well adapted to regions of deficient moisture, it nevertheless gives excellent results in regions of ample rainfall and short summer season. The crop is valuable for both pasture and hay purposes, and in western regions,

where wind erosion occurs, Sudan grass is recognized as one of the most valuable erosion-preventing forage crops.

Sudan grass is usually planted when the soil is warmed up in May or early June; it is drilled or broadcast on a thoroughly fitted, well-compacted seed bed, 20 to 30 pounds of seed per acre. According to seasonal conditions 1½ to 3 tons



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Sudan grass furnishes ample pasturage during late summer and early fall.

of hay should result from this crop. One hay crop per season is produced in the Northern States, whereas in the Southern States two or even three crops may be harvested. If not overgrazed, continuous pasture may be secured from mid-summer until frost comes in the fall. Sweet Sudan, a variety developed in the Southwest, is increasing in favor as a pasture variety.

Lespedeza. Even more rapid than the increase in the use of Sudan grass has been the increase of lespedeza, dealt with in Chapter XXVI. If planted in the early spring at the rate of 30 pounds of seed per acre, hay yields of 1½ to 2 tons or more can be secured; this is ample pasture from mid-summer until growth is stopped by frost. Lespedeza is particularly valuable as a crop to turn under for soil improvement. It is

of greatest importance in the southern part of the Corn Belt and northern part of the Cotton Region.

Soybeans. Soybeans can be employed as a useful emergency crop where the clover crop has failed. They should be planted in late May or early June on ground prepared as for field-beans, and drilled with grain drill or broadcast, at the rate of 1½ to 2 bushels of seed per acre.

Winter vetch is gaining in importance as a soil-improving and forage crop in northern and southern states.

The varieties recommended for hay in the Corn Belt are Early Brown, Manchu, and Wilson; and in northern regions early strains of Ito San and Early Black.

The harvesting is done with the mower after the pods form and start to fill. The hay must be carefully made, particularly during rainy weather. The stems take considerable time to dry out. If the crop is cured carefully in cocks, a good quality of hay can be made from the soybean crop. From 2 to 3 tons of high-protein hay, comparable to clover hay, should result from soybeans.

On land where this crop has not been previously grown, inoculation is necessary.

Winter Vetch and Rye. Winter vetch and rye make a valuable, soil-improving pasture, hay, and seed-crop. It is usual to plant 20 pounds of winter, or hairy, vetch, with 1 bushel of rye. Planting should be done in late August or early September. This combination is a good one to plant at the last cultivation of corn for fall and spring forage and green-manuring.

For hay, the crop should be cut when the vetch is in bloom; for seed, when it is fully ripe. The vetch is separated from the rye with a vetch separator.

For green-manuring and as a cover crop for orchards this combination ranks high. It should be planted in late summer or early fall and turned under when good growth has formed in the spring.

This crop is adapted to northern localities and is used chiefly on light soils.

TABLE 29

ANNUAL PASTURE CROPS

Crops	Rate per Acre	Condition
Rape	5–7 pounds	General
Fall grain	6 to 8 pecks	Late fall
Oats and peas	2½ bushels of a 50–50 mixture	Summer
Sweet clover with grain crop	15 pounds	Late fall

Corn. Of all annual crops, corn can supply in a single season the largest amount of acceptable forage, either for ensilage or for fodder. Its culture is fully treated in Chapter XIX. Varieties that will reach the dented and glazed stage of maturity should be planted for fodder and ensilage.

If a finer texture of fodder is desired, it can be secured by following the old practice of drilling 1 to 2 bushels of seed per acre or planting sowed corn broadcast.

A good corn crop should yield 10 to 15 tons of ensilage or 5 to 6 tons of fodder per acre.

Sunflowers are often mixed with corn. When the crop is planted late, or in northern regions, 6 to 8 quarts of sunflower

seed per acre is the usual amount planted. Sunflowers are handled in the same way as corn for fodder and ensilage and in extremely adverse seasons will usually give better yields than corn.

Millet. Millet is a well-known annual hay crop. The German, common or golden, and Hungarian varieties are most

The dwarf Essex rape provides succulent pasture for hogs and other livestock at a time when native pastures furnish little feed.

generally grown and most highly esteemed. The German millet is a larger-growing type which gives a higher yield of hay. The common millet has finer stems. The Japanese millet makes a much coarser forage than these varieties.

Two pecks per acre should be planted, either drilled or broadcast, on a well-harrowed seed bed, prepared as for corn. The seed should be planted at a shallow depth, about ½ inch, when the ground is well warmed—a week or so after the ordinary time for planting corn.

If planted early, millet may be cut for hay in 40 to 50 days after planting. July plantings require 60 to 70 days. Millet should be cut for hay just after blooming, and before the seeds form, particularly if it is to be fed to horses, since it is safer

and more palatable at that time. For cattle and sheep, it may be left until the seeds are in the late milk stage.

A good field of millet should produce 2 to 3 tons of hay per acre.

Peas and Oats. Peas and oats should be seeded at the rate of 1 bushel of field peas and 1 or 1½ bushels of oats per acre. They should be seeded during April and early May, the earlier the better. They are adapted to the Northern States and Canada.

At the Upper Peninsula Substation, Michigan, in 1917, 10.6 tons of pea and oat forage per acre were produced for the silo, equivalent to about 3 tons of dry hay. Large yields of hay are frequently reported. The peas in a pea-and-oat mixture give a higher protein content to the hay or ensilage produced.

For hay purposes, the crop is cured in much the same way as alfalfa hay is handled. The crop should be cut when the pods are full-grown, but not yet filled, and should be thoroughly cured in small cocks. The Canada field pea is generally used.

Oat Hay. Oats, drilled at the rate of 2½ to 3 bushels per acre in the usual manner, and cut before maturity, furnish a very useful hay crop. It is best, from the point of view of palatability and also from that of feeding value, to cut them in the late milk or early dough stage.

A yield of 1½ to 2½ tons per acre should result from oats utilized for this purpose on adapted soil.

Sorghum. Sorghum may be used for ensilage, fodder, or hay purposes. For ensilage, it is handled in the same way as corn, but may be planted at a considerably later date. The best planting time is about 1 to 2 weeks after ordinary corn-planting season, when the ground is well warmed. For ensilage, sorghum should be planted in rows 32 to 38 inches apart, 8 pounds of seed per acre being used. Sorghum will yield almost as well as corn and make almost as good ensilage.

For hay or fodder, sorghum is seeded with an ordinary

TABLE 30

Short-Season Hay Crops—Spring-Sown

Crops	Rate per Acre	Condition
Oats and peas	2½ bushels of a 50–50 mixture	Heavy soils
Oats and vetch	2 bushels of oats, 20 pounds hairy vetch	Sandy soils

Early-Summer-Sown Crops

Corn	Rate per Acre	Condition
Corn	32 inch rows	Where crop is well adapted
Soybeans	1½ bushels	In Corn Belt and southern part of the Northern States
Millet	25 pounds	Very quick grower

Digestible Nutrients in Dried Roughage

Dried Roughage	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds				Nutritive Ratio
		Crude protein	Carbohydrates	Fat	Total	
Corn fodder	81.7	3.0	47.3	1.5	53.7	16.9
Sorghum fodder	90.3	2.8	44.8	2.0	52.1	17.6
Millet, common	85.7	5.0	46.0	1.8	55.0	10.0
Millet, German	91.3	4.8	49.7	1.7	58.3	11.1
Oat hay	88.0	4.5	38.1	1.7	46.4	9.3
Soybean hay	91.4	11.7	39.2	1.2	53.6	3.6
Peas and oats	83.4	8.3	37.1	1.5	48.8	4.9

grain drill at the rate of 40 pounds per acre. It is cut when the seeds are in the early dough stage, with the ordinary mower, and cured in small cocks. Yields of 3 to 5 tons of dry forage may be expected from sorghum on good land. The Early Amber variety is the best.

SUGGESTIONS

1. When crops fail in rotation, what crops do your local farmers plant? Get opinions on value of each.

2. When short of hay or pasture, what crops do they use? Which are best? Why?

3. What annual crops are used to furnish pasture for hogs, sheep, and dairy cattle?

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CHAPTER XXX

POTATO GROWING

The potato comprises about 25 per cent of the food of European and English-speaking peoples. A greater weight of potatoes can be produced to a unit area than of any other food crop. A. W. GILBERT

The potato crop of the world is used, more than any other crop grown, for direct human consumption. Though a comparatively new crop, of American origin and introduced into Europe in the latter part of the sixteenth century, the potato crop now makes up about one-fourth of the food of Europeans and Americans.

The wild American tuber, used by the Indians in Virginia, was described by an early writer as having "roots like walnuts hanging together as if tied on ropes." From such a plant, our modern, uniformly smooth, large-sized, shallow-eyed, shapely tubers have been developed by selection and better cultural methods.

The following methods are employed by potato growers who are in the business year in and year out and make most of the profit from potatoes:

1. Place the potato crop on soil adapted to it.
2. Plow ground in early fall or early spring and fit the seed bed thoroughly.
3. Get cleanest seed obtainable, of highest-yielding variety.
4. Treat seed to control scab and black scurf.
5. Plant sets of sufficient size.
6. Green-sprout to increase vigor of growth, hasten maturity, and increase yield.
7. Use fertilizer according to soil needs.

8. Plant at the right time, and at proper depth and spacing for your soil.
9. Cultivate frequently and thoroughly.
10. Spray to control insects and diseases which reduce leaf surface and affect the tubers.
11. Harvest when mature, using the most efficient method.
12. Grade to meet United States Standards.

A thrifty field of potatoes well cultivated and properly sprayed.

13. Store in well-ventilated cellar or pits or properly constructed storage houses.
14. Practice hill selection and the tuber-unit method of improvement.
15. Grow potatoes in a good rotation.

Place the Potato Crop on Soil Adapted to It. Potatoes grow best on fertile sandy loams and loams well charged with organic matter and well drained. They can be grown successfully on silt loams and clay loams in excellent condition of tilth, but the greatest commercial development and highest-quality product are found on sandy loams and light loams.

The potato plant is best adapted to regions of cool, moist climate such as prevails in the Northern States of the United

States, Canada, and northern European countries. The greatest commercial development in potato production in the United States is found in Maine, New York, Michigan, Wisconsin, Minnesota, Ohio, Pennsylvania, and Idaho. Early potatoes, however, are produced extensively in the Southern States and the Eastern Coastal Plains for the early market.

Plow Ground in Early Fall or Early Spring and Fit the Seed Bed Thoroughly. Potato ground should be fall-plowed, where possible, to a good depth. A clover or alfalfa sod, which has been well manured with six or eight loads of manure, should be turned under to pave the way for good yields of potatoes. When spring plowing is necessary, it should be done as early as possible, to a depth of 6 or 7 inches. The seed bed for potatoes should be firmly compacted, with surface worked into a condition approaching garden tilth. If the land is thoroughly fitted with disk and harrow, the cost of weed control after the crop is planted is greatly reduced.

Get Cleanest Seed Obtainable, of the Highest-Yielding Variety. It has been estimated that the number of potato varieties grown in the United States exceeds six hundred. Of this great number, six varieties make up at least 90 per cent of the commercial table stock. These leading varietal groups are superior in both yield and quality and have been chosen as standards by leading potato-producing districts.

Of the late potatoes the principal varieties are Rurals, Green Mountain, Burbank, and Katahdin; of the early groups, Cobbler, Triumph, Early Ohio, and Chippewa.

The rural group is the most important from the commercial standpoint. The Rural New Yorker, Carman, Sir Walter Raleigh, Petoskey, and Russet are the leading varieties of this group.

Certified potato seed, which has successfully passed a careful field and after-harvest inspection, is the most reliable class of seed to plant. Good seed potatoes should be of a high-yielding variety and should be as free as possible from scab, scurf fusarium, and other diseases.

Treat Seed to Control Scab and Black Scurf. Potatoes used for seed should be carefully sorted, all discolored, rotted, or injured potatoes being removed and the good ones freed from dirt. In order to control scab and black scurf, the whole potato should be soaked for 30 minutes in a corrosive sublimate solution (bichloride of mercury). The solution is made of 4 ounces of corrosive sublimate mixed with 30 gallons of water. In the preparation of the solution, 4 ounces or a proportionate amount can be mixed with a quart of hot water and added to the 30 gallons. Wooden vessels, such as a barrel or tub, should be used, since the corrosive sublimate dissolves metal containers. The potatoes may be handled in bushel crates which are immersed in the solution for a period of 30 minutes. After each treatment, 1 ounce of corrosive sublimate should be added to the solution and the water level kept to the 30-gallon mark; or after each fourth treatment a new batch may be mixed up, since the solution loses strength in treating the seed.

After treatment, the potatoes should be spread in a cool place away from direct light and allowed to dry. The crates or bags used for storage should be soaked with the solution. *Corrosive sublimate is a deadly poison,* and great care should be taken in the disposal of the solution and all containers. The formaldehyde treatment is also effective. Note Chapter XV.

Plant Sets of Sufficient Size. Best results are secured from large sets, pieces 1½ to 2 ounces in weight or whole potatoes 3 to 5 ounces in weight. A common practice is to cut large tubers to proper size. Cutting should be done just before planting. A loss in yield follows if cut seed is held for several days or more.

Smooth, properly shaped potatoes should be used for seed. The seed treatment should be made before cutting. Each piece should contain two or more strong eyes and should weigh from 1½ to 2 ounces. The seed pieces should be blocky so that the cut surface is reduced and rapid drying is prevented.

Potatoes showing discoloration should be discarded. When possible, cut pieces should be planted immediately after cutting. If necessary to hold over for planting, they should be spread out in a thin layer in a cool, dark place, sprinkled with gypsum or flowers of sulphur, and turned several times a day to prevent heating. Cut surfaces will dry and prevent rapid loss of moisture.

Whole potatoes 3 to 6 ounces in weight are used for late planting under comparatively hot and dry conditions. Many of the most skillful potato growers maintain a special seed plat, often planted several weeks later than the main crop. This plat is given clean cultivation and carefully rogued of diseased plants. Potatoes of small size, ranging from 3 to 6 ounces, are secured; at harvest time, weak hills are discarded. The potatoes saved for seed come from vigorous, high-yielding, disease-free plants.

Green-Sprout to Increase Vigor of Growth, Hasten Maturity, and Increase Yield. By planting green-sprouted potatoes, a more uniform and vigorous stand may be secured and the yield of the crop materially increased. Green-sprouting will also hasten maturity to the extent of several days or a week.

Before green-sprouting, the seed should be treated with corrosive sublimate and laid out on floors or tables in a cool, well-ventilated place for a period of 3 to 5 weeks. Short, green sprouts will develop, and the potatoes will remain in a firm condition for planting. Opportunity is thus offered for discarding all potatoes with weak sprouts.

Use Fertilizer According to Soil Needs. The potato crop will return profit from larger amounts of commercial fertilizer than is used for general field crops. Usually 300 to 1000 pounds of a complete fertilizer, such as a 2–10–5 or 4–12–4, will give profitable returns. Northeast commercial growers use a ton or more of fertilizer to the acre. The fertilizer should be applied broadcast when the seed bed is being prepared, not

TABLE 31

COMPARATIVE YIELDS FROM IRISH COBBLER POTATO SETS OF DIFFERENT SIZES AT THE VIRGINIA TRUCK EXPERIMENT STATION IN STATED YEARS

(*Bulletin* 1248, U.S.D.A.)

(In the columns headed "Yield of Primes, Net" the quantity of seed planted has been deducted, making the number of bushels net, as given.)

Kind of Set Planted	Weight of Set, Ounces	Yields per Acre, 1914				Yields per Acre, 1915				Yields per Acre, 1916			
		Primes, bushels	Culls, bushels	Yield of primes		Primes, bushels	Culls, bushels	Yield of primes		Primes, bushels	Culls, bushels	Yield of primes	
				Actual, percentage	Net, bushels			Actual, percentage	Net, bushels			Actual, percentage	Net, bushels
Whole													
2-ounce	2	87.2	75.8	53.5	67.0	221.7	57.1	79.5	198.2	300.1	96.2	75.7	279.3
3-ounce	3	67.9	85.0	44.4	34.9	264.2	68.3	79.5	228.9	266.7	100.7	78.5	335.4
4-ounce	4	87.1	107.1	44.9	43.1	259.2	79.2	76.6	212.1	367.8	120.2	75.4	321.6
5-ounce	5	....	....	....	....	.....	....	....	.....	391.0	148.8	72.4	338.2
6-ounce	6	121.2	87.5	58.1	55.2	220.4	108.8	67.0	149.8	388.0	168.2	69.8	325.5
Halved													
2-ounce	1	82.9	52.3	61.3	71.9	220.0	36.7	85.7	208.2	216.7	57.7	79.0	195.9
3-ounce	1½	89.2	61.9	59.0	72.7	230.8	40.0	85.2	213.1	374.0	66.0	85.0	358.4
4-ounce	2	118.5	72.7	62.0	96.5	276.7	47.5	85.3	253.2	356.2	72.8	83.0	335.4
5-ounce	2½	....	....	....	....	.....	....	....	.....	389.2	77.6	83.4	362.8
6-ounce	3	123.1	73.8	62.5	90.1	270.8	57.1	82.6	235.5	383.4	82.1	82.4	352.2
Quartered													
3-ounce	¾	....	....	....	....	.....	....	....	.....	357.4	48.6	88.0	349.6
4-ounce	1	....	....	....	....	232.9	37.5	86.1	221.1	346.3	68.1	83.5	330.9
5-ounce	1¼	....	....	....	....	.....	....	....	.....	347.1	57.7	85.7	333.9
6-ounce	1½	....	....	....	....	245.8	43.3	85.0	228.1	342.5	62.5	84.6	326.9

more than 100 pounds being drilled in the hills with the potatoes.

Manure is an excellent fertilizer for potatoes, contributing much more to the growth of the plant than is represented by the fertilizer content, because the moisture-holding capacity of the soil is increased. Eight to twelve or more loads of manure, applied before plowing potato land, and turned under in the fall or early spring, will give excellent results. It should be supplemented with 300 or 400 pounds of acid phosphate.

Plant at the Right Time and at Proper Depth and Spacing for Your Soil. Early varieties are usually planted just as soon in the spring as the ground can be worked, usually a week or so before the last killing frost. Early potatoes require 60 to 80 days for maturity, and should be planted as early as possible in the spring, from late March to early May. Late potatoes require 100 to 130 days. Since they make their best growth during late summer and fall, it is usual to plant in late May or early June.

Early potatoes on sandy loam soil should be planted to a depth of 3 or 4 inches. On heavier soil 3 inches is sufficient, since the ground does not become warm so rapidly. Late potatoes should be planted to a depth of 3 or 4 inches on loams or silt loams and 4 to 6 inches on sandy loams.

The spacing depends largely on the fertility of the soil. On fertile soils potatoes can be planted closer than on less fertile land. Early potatoes can be planted closer than late potatoes since they do not make as great growth. The usual practice in most potato regions is to plant in rows 36 inches apart, with the hills 12 to 18 inches apart. If the seed weighs approximately 1½ ounces, 15 bushels of seed will be needed.

Most growers use machine planters. These give a more uniform planting than the hand method. Two types of machines are used: the one-man type, which automatically drops the seed, and a two-man type, which carries the man or boy behind the machine to see that the drop is uniform. The two-

TABLE 32

SUMMARY OF DATA OBTAINED FROM RATE OF PLANTING EXPERIMENT

(H. C. Moore, *Michigan Experiment Station Quarterly*, February, 1926)

Plot No.	Treatment	Total Number of Pounds	Spacing Distance	Total Number of Bushels per Acre	Number of Pounds Hollow	Percentage Hollow by Weight	Number of Pounds Over Size	Percentage Over Size	Number of Tubers in 20-lb Sample	Average Weight Tubers (Oz.)
				Planted May 30						
1	Not irrigated	230.0	36 × 18	307	0	0	7.9	3.43	57	5.6
2	Irrigated	215.7	36 × 36	290	33.5	15.43	16.0	7.41	32	10.0
3	Not irrigated	183.0	36 × 36	244	6.0	3.28	5.2	2.84	44	7.3
4	Irrigated	310.5	36 × 18	312	16.5	5.31	16.0	5.15	48	6.7
				Planted June 25						
5	Not irrigated	188.5	36 × 18	251	0	0	0	0	72	4.4
6	Irrigated	206.2	36 × 36	275	10.5	5.09	3.9	1.89	57	5.6
7	Not irrigated	187.5	36 × 36	250	3.2	1.7	3.9	2.08	56	5.7
8	Irrigated	276.5	36 × 18	369	7.0	2.53	1.0	0.36	60	5.3

Number of rows per plot, 6
Size of plots, 60 × 18 feet
Variety—Russet Rural

Date of first killing frost, October 10
Date of harvesting, October 21

In this experiment, the 36 × 18 inch spacing gave an average increase in yield over the 36 × 36 inch spacing of 34.6 per cent for the early planting and 18.1 per cent for the late planting. The average percentage of hollow heart in the early planting with 36 × 36 inch spacing was 9.35 compared with 2.65 per cent for the 36 × 18 inch spacing. The late-planted 36 × 36 inch spacing gave an average percentage of hollow heart of 3.39; the 36 × 18 inch spacing averaged 1.26 per cent hollow heart. This should be significant to potato growers since this result indicates that closer spacing reduces the amount of hollow heart and increases the yield.

man planter will give a very accurate stand with less than 1 per cent of misses. On rough land, or where potatoes are put out in a small way, the hand planter or jabber is used.

Cultivate Frequently and Thoroughly. As soon as potatoes are planted they should be harrowed lengthwise of the

rows. Several harrowings may be given before the crop appears aboveground. It is important that this part of the cultivation be carefully attended to, since it is much cheaper to control weeds with the harrow than with the cultivator.

As soon as the plants appear in the row, work with the cultivator should be started. The first cultivation should be close to the hills. Successive cultivation should be shallow, since the roots of the potato plants interlace between the rows when the plants are a foot or so high. Cultivation should cease when the plants are in full bloom.

Riding cultivators are in general use in potato sections and give a more uniform cultivation. Level culture is best except in regions where rainfall is heavy and the practice of ridge culture gives increased yields. Ridging in regions of average or deficient rainfall offers greater surface for the evaporation of moisture.

Spray to Control Insects and Diseases which Reduce Leaf Surface and Affect the Tubers. By proper spraying with Bordeaux mixture and arsenical poison the vigor of growth and uniformity of potatoes can be markedly increased. It is important to preserve the green leaves of the potato plant. Insects and potato diseases tend to reduce the green leaf surface of unsprayed fields, thereby reducing the yield of potatoes. DDT applied as a spray or dust of 3 per cent strength has been found to be very effective in controlling the Colorado potato beetle and the virus-carrying leaf hoppers and other insects that injure the potato.

The first spraying should be done when the plants are 4 or 5 inches high, the next at intervals of 10 days or 2 weeks. Usually four or five sprayings are given per season, as weather conditions require. During seasons of frequent rain, frequent spraying is necessary. It requires about 100 gallons to spray an acre when plants are large, and about one-half this amount, sprayed early in the season, if the plants are smaller.

The best types of spraying machines carry spray nozzles which reach both the under and upper side of the leaf and

Pennsylvania State College, Agricultural Extension Service

Success in growing potatoes often depends on effective spraying to control potato diseases and insects.

expel a fine mist-like spray under high pressure—arsenical preparations for chewing insects, such as the Colorado beetle, and Bordeaux mixture for blight and leaf hoppers. A 4–4–50 Bordeaux is used with 1 pound of Paris green, and 2 pounds of powdered arsenate of lead, or 4 pounds of arsenate of lead paste per 50 gallons of Bordeaux. The Bordeaux solution is made of 4 pounds of copper sulphate (blue vitriol) dissolved in a wooden barrel in 20 gallons of water. The blue vitriol crystals are suspended in a burlap bag and usually several hours are required for complete dissolution. In a separate barrel, 4 pounds of quicklime should be slaked gradually by the addition of slight amounts of water until the lime is finely crumbled. The water is then added and the lime mixed to the consistency of thick cream. The solution is then made up to 25 gallons with the addition of water. If good quicklime is not available 6 pounds of hydrated lime may be mixed with 25 gallons of water. The copper sulphate (25 gallons) and the lime solution are then poured together through a lime strainer into a spray tank for immediate use. A strong solution of Bordeaux may be made as follows: Mix 50 pounds of copper sulphate with 50 gallons of water. In a separate tank, gradually slake 50 pounds of quicklime and add water to make up 50 gallons. The solutions should be kept separate; they will hold their strength for several weeks.

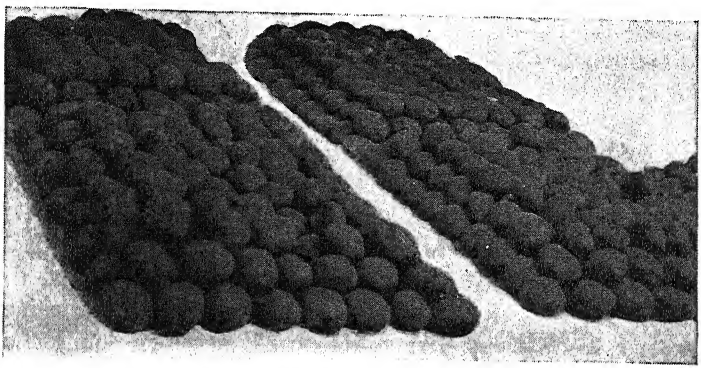
To make Bordeaux, pour 4 gallons of copper sulphate solution into a spray tank; add 30 gallons of water. Pour in 4 gallons of lime solution, mix thoroughly, and add water to bring to 50 gallons. Strong solutions should not be poured together.

Harvest when Mature, Using the Most Efficient Method. Potatoes should be harvested when mature or when vines have been killed by freezing. The crop should be dug during clear, cold weather, whenever possible. After being dug, the potatoes should be allowed to dry on the ground for several hours in order to let skins dry and toughen.

Digging machines are in general use in the potato-growing

regions. A machine will dig 3 to 8 acres a day with less injury to potatoes than the average hand digging. In digging by hand, care should be taken not to injure the potatoes with the fork. One-half acre is a good day's work in hand digging.

Low-wheeled platform wagons or sleds are used to haul the crop from the field. The potatoes are picked up in bushel crates and hauled to grader or storage cellar.



The market demands a uniform medium-sized, shallow-eyed potato.

If the crop is immature, it should be allowed to cure for several days in piles in the field, carefully covered by straw.

Fields severely affected by late blight should not be dug for a week or two after the vines are dead, in order to allow infected tubers to rot in the field.

Grade to Meet United States Standards. The potato market demands shipments of uniform quality and size, free from diseased, rotten, or discolored potatoes. A mechanical sorter will rapidly grade potatoes and free them of dirt, but it is necessary for the grower to pick out rotten potatoes and discolored ones.

Store in Well-Ventilated Cellars or Pits or Properly Constructed Storage Houses. In important potato-producing sections, it is the custom to store the bulk of the potato crop after harvest until it is shipped at a later date in winter and spring.

In order to prevent great loss, it is important that proper storage conditions be provided. The potatoes placed in storage should be sound, clean, and dry. The temperature of the potato storage cellar or house must be high enough to prevent freezing and cold enough to keep tubers from sprouting. A temperature between 35° and 40° F. is advisable.

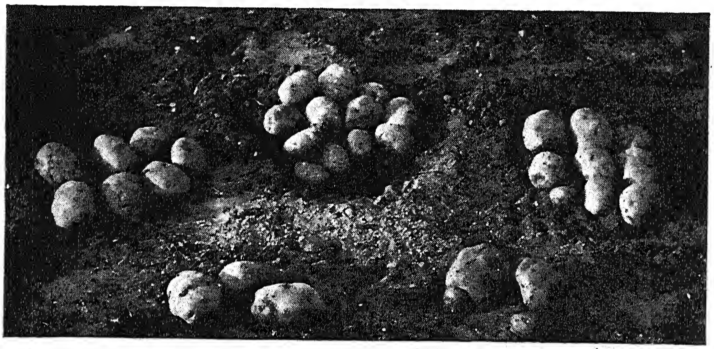
An adequate system of ventilation must be maintained. Potatoes in storage are constantly giving off moisture and gases. Moist air must be drawn off and a constant and well-regulated circulation of air provided. When potatoes are first put in storage they go through a sweating process which raises the temperature. Doors, windows, and ventilators should be kept open to lower the temperature rapidly and so prevent heating and rotting. Large piles, 5 feet or more in depth, should be aerated with special ventilators which carry air deep into the pile. All light should be kept out.

Pits should be dug in well-drained soil. It is usual to dig a trench 8 to 12 inches deep, 4 to 6 feet wide, and sufficiently long to carry the crop. The potatoes are piled in a long narrow heap. Wooden flues above the top are provided at intervals of 8 or 10 feet. For the first few weeks, the heap is covered with 6 or 8 inches of straw with a slight covering of earth. With the approach of freezing weather, the earth layer is deepened and another layer of straw and a foot or so of earth added. During extremely cold weather, the flues are partly closed to prevent freezing.

Practice the Tuber-Unit Method of Improvement. The yield and market quality of the potato crop can be greatly improved by proper selection methods.

The Hill-Selection Method. At time of harvest, desirable hills are dug by hand and those carrying six or more smooth, clean uniform tubers of proper market size are reserved for planting the next year, either in a special seed plat or in the general field, if it is not too large. If a special seed plat of half an acre or more is maintained, large increases for the following year's planting on a field scale can be secured. The seed

plat should be carefully rogued when cultivated, and all weak, diseased, or abnormal plants dug and removed from the field. This field should be given the usual spraying. If whole potato seed is desired, it should be planted two weeks or a month later than the usual time for planting the main crop. Immature seed potatoes give best results. Hill selection should be prac-



Michigan Exp. Sta.

Individual potato plants vary greatly in the yield and quality of potatoes produced. By hill selection the yields of many varieties can be greatly improved.

ticed in this plat for planting another seed plat the following year.

The Tuber-Unit Method. This method is more effective. One hundred or more very desirable tubers are selected, preferably from high-class, hill-selected stock.

These tubers should be smooth, free from disease, uniform in shape, and 8 to 12 ounces in weight. The seed is treated and planted on a selected area of soil.

The tuber is cut for planting lengthwise through center in four equal sections. Each section is dropped at the usual distance in the row; a space of 3 feet is left, and the sections of the next tuber are dropped, and so on. Ordinary culture and sprayings are necessary. The crop is harvested by hand, and the product of each tuber unit is studied. The leading units which

produce the greatest number and weight of uniform, clean, smooth potatoes of best market quality are selected for increase and are planted the next year in an increase plat to secure stock for extensive planting the following year.

Grow Potatoes in a Good Rotation. It is of particular importance that potatoes be grown in a carefully planned crop rotation which will maintain or increase organic matter and nitrogen in the soil and provide proper conditions for the potato crop. On lighter soils, such as sandy loams and light loams, the following rotations are effective:

A. (1) Potatoes; (2) rye; (3) clover.
B. (1) Potatoes; (2) rye seeded to sweet clover; (3) sweet clover for pasture or seed.
C. (1) Potatoes, rye, and vetch; (2) rye and vetch; (3) alfalfa for 3 to 5 years, followed by potatoes or corn.

The following is a strong rotation:

(1) Potatoes; (2) oats; (3) clover or sweet clover; (4) corn or beans; (5) oats or barley seeded to clover or sweet clover; (6) clover or sweet clover.

Rotations are necessary not only to increase fertility but also to insure the control of insects and potato diseases.

Additional Information

The Origin and History of the Potato. It is probable that the potato originated in the higher altitudes of the Andes of Peru. The wild potato is found growing as far north as the Colorado Rockies. The early Spanish conquerors of Peru and Chile found potatoes in common use among the Indians. They were taken from America to England by the Raleigh Expedition about 1586.

Later, the potato became the most important food of Ireland, and today it ranks as a leading food of European countries.

The culture of the potato was brought into Colonial Amer-

ica by Irish immigrants, and it became important early in the eighteenth century.

Importance and Uses. The importance of the potato in our regular diet is well known. Potatoes are cooked in a great variety of ways: boiled, baked, mashed, fried, and used in salads, soups, and so on. Potato flour is an important staple, and the crop is used as a leading source for laundry and sizing starch.

In Europe the potato is an important stock feed and is also used extensively in the manufacture of alcohol.

The Market Grades of Potatoes. In order to improve the market grades of potatoes, the United States Government and leading potato states have cooperated in the establishment of uniform potato grades. When potatoes are graded on the farm the culls are available for feeding, and the market is supplied with a more uniform supply of higher grade. Copies of market grades for potatoes can be secured from your state department of agriculture, agricultural college, or the United States Department of Agriculture.

SUGGESTIONS

1. In fall, visit local fields at harvest time. Note varieties harvested. Get information on production methods employed, seed planted, treatment, and so on.

Watch grading operation in the field or at a local marketing point. What are the advantages, to growers, of grading?

Note storage conditions. Describe the ventilation system of a good storehouse.

2. Get peck lots of potatoes grown in your locality. Study characteristics of each.

3. In spring, get peck lots of seed to be planted. Note condition, freedom from disease, uniformity, and so on. Compare with peck lots of certified seed.

4. In the fall, help a potato grower in his hill-selection work. Discuss advantages and methods.

5. In the spring plant a tuber-unit plat for next fall's harvest. Plant increase the next spring.

6. Grade a number of different lots according to U. S. grades.

7. Conduct a potato show of locally grown potatoes.

8. Get best seed stock (1 peck or 1 bushel) of highest-yielding, most marketable variety obtainable, and plant local variety test on your farm or that of cooperator.

9. Plant demonstration of treated and untreated seed.

10. Write the secretary of your state certified seed-potato growers' association for rules and regulations governing certified seed growing. Visit a certified seed-potato field, or a field planted for general market with certified seed. What are the outstanding advantages of certified seed?

11. Green-sprout peck lots of Green Mountains, Russet Rurals, Early Ohios, and Cobblers. Note color of sprouts. Plant in comparison with seed not green-sprouted.

12. Secure bulletins on potato growing from the state college of agriculture.

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CHAPTER XXXI

FIELD-BEAN GROWING

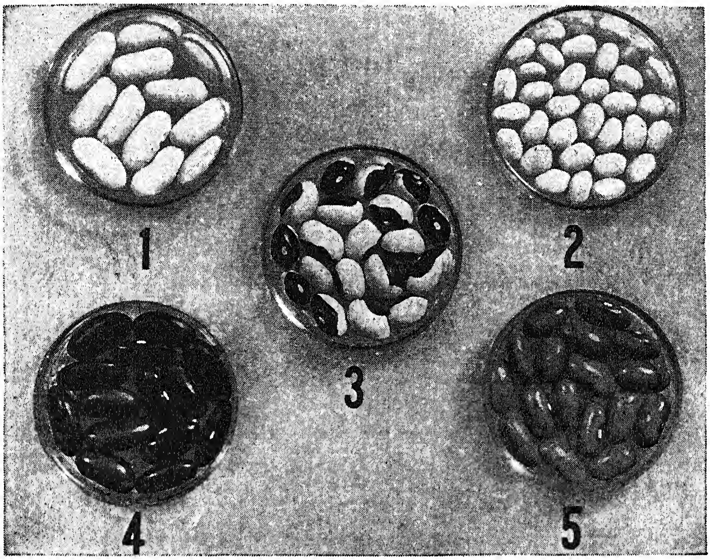
Indian corn, the white and sweet potato, the tomato, and the white pea-bean are the American Indian's greatest contributions to civilization.

Beans have long been a popular food in American homes. During recent years, the development of the canning industry has increased the demand for beans and the variety of ways in which they are offered for food. During the war years, bean production was greatly expanded. Further increase in the demand for field-beans can be expected from year to year, as the population increases and new uses for the crop are developed.

1. Plant clean seed of best variety to grow big crops of clean beans.
2. Plow early for best results, and prepare seed bed thoroughly.
3. Fertilize crop where needed.
4. Plant on well-warmed seed bed.
5. Give shallow cultivations, frequently repeated.
6. Harvest as soon as mature, before the pods split, and thresh with beaner.
7. Grow beans in rotation.

Leading Commercial Varieties. The navy bean, or common white pea-bean, is produced in the greatest quantity and is most widely distributed. This bean is of American origin; it became known for the first time to white men when the territory which is now New York State was settled. The Iroquois Indians grew this small, round, white pea-bean with corn. The Indian bean rapidly became a favorite with the early settlers. Later, it became known as the navy bean, because of the large demand which developed for this bean for

naval and marine food-supply purposes. The navy bean, when properly matured and dried, has remarkable keeping qualities. It may as appropriately be called the army bean, since it furnishes one of the important foods of our army.



H. R. Pettigrove

Types of beans: 1, white kidney; 2, navy or pea-bean; 3, yellow eye; 4, red kidney; 5, brown Swedish.

The navy bean is an important crop in those parts of the Lake States which are favorable to its growth. It has become one of the chief cash crops in Michigan, which leads in the production of navy beans, as well as in New York and Vermont. It is also produced in quantity in California, Colorado, and Idaho. Navy beans are of two types: the white pea-bean, almost round in shape; and the medium bean, somewhat larger and more oval.

In Michigan, New York, Wisconsin, and Minnesota, the Robust variety has given the highest results in yield tests. It

is a medium pea-bean, developed by Professor F. A. Spragg of the Michigan Experiment Station. The Robust is resistant to blight and anthracnose, and apparently immune to mosaic, a bean disease causing much loss in New York State and present also in Michigan. The Michelite is considered superior for canning purposes.

The red kidney bean is next in importance in Michigan, New York, and Wisconsin. This bean is used mostly for canning purposes. White kidney beans are adapted to the same territory but do not meet with the strong demand of the red kidneys.

In New York, the Wells Red Kidney is strongly recommended because of its resistance to anthracnose. The Wells Red Kidney is a development of the plant-breeding work at the Cornell Experiment Station.

The marrowfat bean, a white bean larger than the navy bean, is grown chiefly in New York and New England for eastern consumption. The Boston Yellow Eye is another eastern variety grown to a somewhat limited extent for local consumption. In California, the Black Eye, Pinto, Tepary, and navy bean are most widely grown. Lima beans, both dried and for canning, are produced to a large extent in southern California.

The Great Northern, grown chiefly in Idaho and Montana, has achieved great commercial importance. It is a white bean, larger and longer than the common navy, and has excellent cooking qualities.

Beans Not a Poor-Soil Crop. The common saying, descriptive of poor lands, that "they are too poor to grow beans," did not originate among farmers who knew beans. The soils of the best bean districts of New York and Michigan are fertile loams, silt loams, and clay loams of the glaciated lake-bed areas. They are moisture-retentive soils, well supplied with organic matter and the mineral elements of fertility, particularly calcium. In California, the best bean soils are the fertile, water-deposited soils bordering the sea in southwestern

California. The bean-producing area is further limited by the peculiar seasonal requirements of the crop. A uniform growing season, characterized by cool nights, ample rainfall, and a high humidity, is needed for beans. This crop is, therefore, restricted to areas of desirable soils in the region of the Great Lakes and bordering the sea. In the Corn Belt, though the soil may be well suited to beans, the crop fails to give profitable results because of the hot, dry spells which frequently occur during the growing season and prevent the suitable filling of the pods.

Beans are not adapted to acid or sour soils; on muck soils and poorly drained clays, they are inclined to mature too late, and to suffer great loss from disease injury and frost.

Plant Clean Seed of Best Variety to Grow Big Crop of Clean Beans. Good seed is of the highest importance in bean growing. As a general rule, home-grown beans, which are clean and free of disease, from high-yielding fields give best results. The bean diseases—blight, anthracnose, and mosaic—are carried in the seed; hence it is necessary to get seed produced in fields relatively free of these diseases.

Blight is a bacterial disease which greatly decreases the yield of affected bean fields and results in a high pick of the harvested crop, owing to the presence of a large percentage of dark yellowish or spotted beans. Injury from blight is lessened by planting clean seed.

Anthracnose is a fungus disease which also causes a great increase in the pick of the harvested crop and lessens the yield. Infected seed beans show reddish or brownish spots. Anthracnose is effectively controlled by planting seed from clean fields.

The mosaic disease greatly reduces yields by curtailing plant growth. Beans from affected fields show a high percentage of small, immature, darkened beans. Clean seed from clean fields is the best control measure.

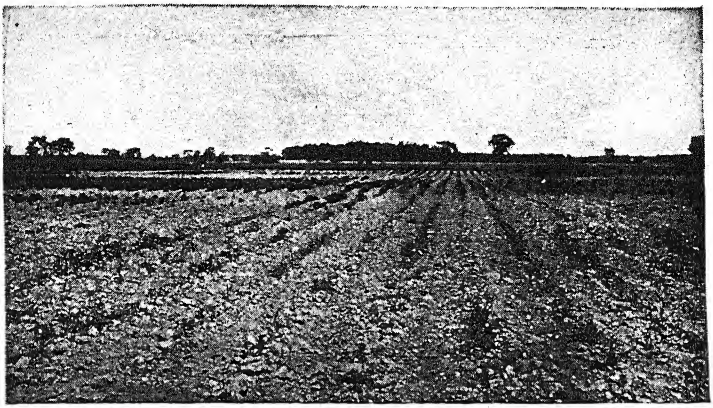
Clean, plump, viable seed should be planted; discolored, diseased, and immature seed should be culled out.

Plow Early for Best Results and Prepare Seed Bed Thoroughly. It takes 4 to 6 weeks after plowing to get a seed bed in good condition for the planting of beans. Plowing should be done in the fall or as early in the spring as possible. Early plowing gives opportunity for the seed bed to settle and provides time in which to secure a seed bed comparatively free of weeds, by the proper use of the harrow and the disk. The roller and the cultipacker are generally used to pack and pulverize the seed bed. Beans planted on late-plowed fields are likely to be more seriously affected by diseases and are more difficult to keep free of weeds during cultivation. To fit the seed bed for beans, the roller should be used to break clods and fill air spaces, and then the roller with harrow to save moisture. The seed bed should be disked and harrowed at weekly intervals to kill weeds as they germinate. Early plowing and thorough fitting greatly lessen the labor and cost of later cultivation and effectively control the bean maggot, which often causes injury on newly plowed clover sod or newly manured land.

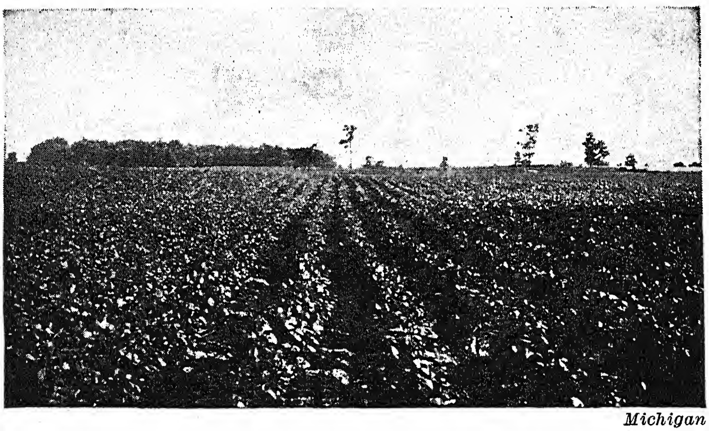
Fertilize where Needed. Manure and mineral fertilizers are effective in increasing yields and cheapening costs per bushel in bean production. Manure should be applied, where possible, to the previous crop. From 6 to 8 tons of manure, supplemented by 200 or 300 pounds of acid phosphate, usually pave the way for a big crop of beans at a low cost per bushel. Acid phosphate aids in hastening the maturity of the crop and hence lessens danger from frost damage in the fall.

Complete commercial fertilizers, of a 2–12–4 or a 2–16–6 formula, are effective. They should be used at the rate of 200 to 300 pounds per acre, preferably applied broadcast before planting. Only a small amount, 50 to 75 pounds, should be drilled in the row with the seed beans. Acid soils should be limed before they are planted with beans. (Note fertilizer recommendations, Chapter VII.)

Plant on a Well-Warmed Seed Bed. The planting time for beans in the Lake States ranges from May 25 to June 25.



Field beans on poorly drained ground.



Michigan

Field beans on tile drained ground in an adjoining field.

Good drainage frequently determines whether the bean crop is harvested with profit or loss.

About June 10 is the usual date in most of the bean districts. It is best to wait until the seed bed is well warmed and worked into an excellent condition of tilth, rather than to plant when cold or wet. Beans require almost ideal conditions for even germination. Every bean seed planted is pushed out of the ground, hence the need for a well-prepared seed bed. Unless the start is uniform, the harvested crop is not likely to be uniform in maturity; this lack of uniformity means a higher pick and difficulty in curing and threshing.

The amount of seed used in planting an acre depends upon the variety. From 20 quarts to 3 pecks of ordinary pea-beans and 5 or 6 pecks of kidney beans is the usual rate. An ordinary eleven-holed grain drill is commonly used in planting. Every fourth hole is left open and the drill wheel allowed to follow its own track on the return; thus three rows, 28 inches apart, are planted with each passage. A two-row corn planter, equipped with special bean plates and narrowed up to plant 28-inch or 32-inch rows, may also be used to drill beans. Special bean drills are available in bean-growing districts. Beans should be planted to a depth of 1 to 2 inches.

Give Shallow Culivation, Frequently Repeated. The first cultivation should be given as soon as the plants are high enough to make it easy to follow the rows. This cultivation should go close to the plants and fairly deep. The next cultivation, in a week or ten days, should be farther from the plants and not so deep. Later cultivations should be shallow, since the feeding roots of the bean plants come close to the surface. Cultivators, carrying numerous small or medium-sized shovels or blades, are most desirable for later cultivations. The blade types of equipment, known as duckfeet, sweeps, and half sweeps, are particularly effective in weed control and are used often for the first cultivation. Four to six cultivations are necessary, as a rule. Beans should not be cultivated when wet with dew or rain, since at that time the bean diseases, blight, anthracnose, and mosaic, are most easily carried from plant to plant.

The rotary hoe is now being effectively used in the cultivation of beans. About 2 or 3 days after planting, the beans are cultivated with the rotary hoe, and the cultivation is repeated every 4 or 6 days until the plants bush out and leaves are clipped. One or two cultivations with the ordinary cultivators are then made. The use of the rotary hoe greatly reduces the cost of bean cultivation.

Harvest as Soon as Mature and before Pods Split, and Thresh with Beaner. The early method of harvesting was to pull the mature bean plants by hand, cure in stacks or piles in the field, and thresh with a flail. At present, the bean harvester is used, and the labor of bean pulling is greatly lessened. This implement consists of a frame on wheels carrying two heavy knives. These knives, or blades, slip along underground just beneath the surface, pulling and throwing together two rows of beans at a time.

The harvesting should be done when the plants are mature, but should not be delayed until the pods are too ripe, as at this stage shattering is likely to occur. After they are pulled, the beans are forked into piles or, if the field is free from straw or trash, a side-delivery rake may be used in windrowing. After several hours' drying, the crop should be forked into cocks, built high and small at the bottom to allow rapid curing. After a period of 4 to 7 days in good drying weather, the crop should be stored under a roof or in a well-constructed stack. Threshing is done in the barn or stack with a special bean thresher. The bean thresher carries one cylinder operated at a low speed, and a second at a high speed. The first cylinder threshes overripe beans with the minimum of splitting. The second, or rapid, cylinder threshes immature pods much more effectively. An ordinary grain separator can be used to thresh beans if every other concave is removed and the speed of the cylinder is regulated. Bean straw is valuable roughage, particularly in sheep and cattle feeding, and should be carefully saved for feed.

The average yield per acre of beans in the leading eastern

bean states is about 12 bushels. Yields of 18 to 20 bushels are considered good yields, but occasionally very high yields of 35 bushels or more are reported.

Grow Beans in Rotation. For continued success in production, the bean crop must be included in a good rotation. Beans after beans soon result in low yields, owing to the rapid decrease in organic matter and the increased injury due to bean diseases and insects. A good clover sod is considered excellent preparation for the bean crop. Such a rotation as the following is well adapted to beans:

First year, beans; second year, wheat, rye, barley, seeded to clover; third year, clover.

Corn or potatoes can be included either before or after beans, in a four-year rotation, such as the following: corn; beans; small grains; and clover. A longer, and hence more desirable, rotation can be secured by seeding timothy or alsike, or both, with the clover, allowing the field to remain in meadow for two or more years. The following are suggested as strong rotations:

A. *On a farm with little livestock:* (1) corn; (2) oats; (3) clover; (4) beans; (5) wheat; (6) clover.
B. *For combined stock and crop farming:* (1) corn or beans; (2) oats, barley, or wheat; (3) red clover, alsike, and timothy (hay); (4) pasture.
C. *Alfalfa rotation:* alfalfa 3 to 6 years, followed by corn, beans, oats, or barley, seeded to alfalfa.

Additional Information

Cull beans and bean pods should be fed on the farm. Cull beans, when cooked and combined with carbohydrate feeds, such as corn, barley, or cooked potatoes, make an excellent ration for either growing or fattening pigs.

When they can be bought considerably more cheaply than corn, cull beans, uncooked, make an excellent addition to the

ration of fattening lambs. One-third of the ration of fattening lambs may well consist of cull beans, and, where the beans are especially cheap, as much as one-half of the ration may consist of them. When this amount is being fed, however, it is necessary to watch the lambs very carefully to see that digestive disturbances do not occur.

Bean pods are also an excellent roughage for feeding either fattening lambs or breeding ewes. They have a value for this purpose which is approximately one-half that of clover hay.

When fed on corn and cull beans, hogs should always have access to mineral matter and to alfalfa or clover hay in a rack.

The ration for dairy cows should not contain in excess of 25 per cent of cull beans, and it is preferable to have less than that amount. Cooking increases the palatability.

A small type of mechanical bean picker has been developed and is in use by farmers to machine-pick their own crop. They retain the cull beans for feeding and offer for sale beans of low pick.

Marketing the Bean Crop. As beans come from the field, they usually carry 4 to 12 pounds per hundred of discolored or cull beans. These are removed by first running the beans over mechanical pickers, which take out a large percentage of the culls and small pebbles. They must then be handpicked to remove undesirable beans which the bean-picking machinery cannot pick out.

When the moisture percentage of the bean crop exceeds 20 per cent, the beans must be dried in artificial dryers, which reduce the moisture content to 17 per cent, or below.

Approximately 35 per cent of the bean crop of Michigan, New York, Wisconsin, and Minnesota is used in preparing the highest quality of canned beans. The remainder of the crop is distributed through wholesale and retail grocers.

By the establishment of uniform grades and a carefully regulated inspection system, the market for beans has been improved.

SUGGESTIONS

1. What is the average yield of beans in your county?

2. Name neighboring bean growers who produce more than the average yield. What was their acreage and total yield? What varieties did they grow? Source of seed? When was the bean ground plowed? How fitted? When was the crop planted? How many cultivations were given? When and how was the crop harvested and threshed? What was the pick? When was the crop sold and what price was received?

Do these leading growers grow beans in rotation? Do they use fertilizer? Estimate cost of producing per acre and per bushel. What net profit was received?

3. Do you know instances where the yield was lower than the average? Why was it lower? Estimate the cost per bushel and per acre in case of average production and below average production. Figure net loss or gain per acre and per bushel.

4. What is the average pick of your neighborhood? The highest? The lowest? How can the percentage of culls or pick be lessened?

5. In the fall, visit bean fields at threshing time. Notice methods employed. Get samples from separator spout. Estimate pick. What does it consist of?

6. Ask threshermen about leading yields. See growers who produced them and find out variety, name, and methods employed.

7. In winter or spring, get samples of seed to be planted. Note condition and pick. Test seed and report to farmer. Describe characteristics of best seed.

8. Get samples of each grade from your local handlers. Try your hand at grading, using local standards and a number of varying lots.

In the spring, get 1 peck or 1 bushel of the best varieties obtainable. Conduct a variety test on your farm or that of an interested cooperator. Note results.

9. Secure market grades from the Bureau of Markets of the U.S.D.A.

REFERENCES

United States Department of Agriculture, *Yearbook*, 1943–1947, pp. 333–337.

CHAPTER XXXII

SUGAR-BEET GROWING AND THE GROWING OF OTHER ROOT CROPS

As long as our home markets need more home-grown sugar, the sugar-beet crop rightly handled will stand forth as a community builder—furnishing profit to growers and laborers, maintaining large industries, increasing the material welfare of communities, and contributing to national stability and independence.

Sugar beets have become one of the leading sources of sugar in the United States; they furnish an even greater proportion of the sugar used in European countries. The cheapness and abundance of the supply of this energy-producing food are largely due to the development of the beet-sugar industry during the past century. Sugar beets are best adapted to regions of ample rainfall and a temperature sufficiently warm to give a large tonnage, but cool enough to give a high sugar content. The average mean temperature for the months of June, July, and August must approximate 70° F., and the rainfall must approximate 3 to 4 inches per month in the humid areas. Where irrigation is practiced, the average crop requires 20 to 30 inches of water per season. On fertile, well-drained soils in the Northern States and the northern part of the Corn Belt, sugar beets do well. They are also well adapted to favored regions of the West and Southwest where irrigation is practiced. A high tonnage per acre markedly increases profits in growing this crop.

In recent years great progress has been made in the planting of sugar-beet seed, reduced to a single germ by mechanical treatment and "pelleted" by covering the seed with a plastic

coat—thus greatly reducing production cost by making blocking and thinning unnecessary. Successful sugar-beet harvesting machinery is now in use.

The following suggestions will prove helpful to those who desire to get the best results from sugar beets in the Northern States and the northern part of the Corn Belt:

1. Grow beets on fertile loams, silt loams, and clay loams, near 70° F. summer isotherm.
2. Plow in fall or in early spring.
3. Prepare the seed bed thoroughly, beginning as early as possible in the spring.
4. Plant seed of high germination at the right time.
5. Fertilize properly for maximum profits.
6. Block and thin to strongest plants, properly spaced.
7. Cultivate and hoe often enough to keep free of weeds.
8. Harvest when mature and when sugar yield is greatest.
9. Top and haul immediately, or cover heaps with tops.
10. Grow beets in carefully planned rotation.
11. Tile-drain to increase yields and insure crop in wet seasons.
12. Apply lime where needed.
13. Feed tops, leaves, and sugar-beet pulp.

Grow Beets on Fertile Loams, Silt Loams, and Clay Loams, near 70° F. Summer Isotherm. Beets do best on fertile, well-drained loam, silt loam, and clay loam soils. Light loams and sandy loams may produce beets of high sugar content, but will not usually yield a sufficient tonnage per acre to justify expansion of production on these soils, except where such soils are in an unusually high condition of fertility. Muck soils tend to produce beets of comparatively low sugar content, though yields may be good. Proper fertilization of muck soils with potash and phosphoric acid will often result in the production of beets of acceptable quality.

Sugar-beet growing should be expanded to fertile, well-drained loams, silt loams, and clay loams that commonly produce good yields of corn or small grains. On such soils, both

a high yield and a desirable sugar content will result from proper cultural methods.

Plow in Fall or in Early Spring. For the proper development of the beet roots, the soil must be well prepared to a good depth. Fall plowing to a depth of 7 to 10 inches is considered the best initial preparation. The exposure of the soil to winter action controls many insect pests and insures the proper mellowing and settling of the furrow slice. Fall-plowed land is usually in best condition to be readily worked into an excellent seed bed at an early date the following spring. If spring plowing is necessary, it should be done as early in the spring as the land is in proper condition for plowing. Disking before plowing in the spring is advisable, since loose ground on the surface fills the furrow bottom with fine material; this process makes it easier to prepare a proper seed bed. Since less time is available for weather action, spring plowing should not be quite so deep as fall plowing.

Prepare the Seed Bed Thoroughly, Beginning as Early as Possible in the Spring. The yield of beets depends largely on the stand secured. A uniform stand can only be obtained if beets are planted on a well-prepared seed bed and proper attention is given to thinning and cultivating. The seed bed is the foundation of a good stand.

Fall-plowed land can be prepared at an earlier date in the spring and offers a longer period for working into proper condition than spring-plowed land. By disking and harrowing frequently with the spike-tooth and spring-tooth harrow and rolling with the cultipacker, such land can best be brought into proper condition for planting. Spring-plowed land should be firmed with a weighted roller or cultipacker and harrowed immediately after plowing. It should then be disked and harrowed at frequent intervals until planting. The final preparation immediately before planting on either spring-plowed or fall-plowed land should be made with a spike-tooth harrow or a heavy plank drag. *Intensified effort in preparing the best*

possible seed bed will repay the grower by greatly lessening the work and expense of weed control after the crop is planted.

Plant Seed of High Germination at the Right Time. The date of planting varies with the region; it usually coincides with corn-planting time. In Michigan, northern Ohio, northern Indiana, and Wisconsin, planting time ranges from May 1 to May 20. In the Mississippi Valley the planting season begins as early as April 1, continuing until May 1. In southern California the planting season ranges from October 1 to April 1, and in the Sacramento and the San Joaquin Valleys planting dates range from January 15 to March 15. The proper period for planting is when the soil is well warmed and danger of severe frost is past. Comparatively early planting on a well-worked seed bed gives highest yields and quality.

The seed is drilled with a special beet drill, which may be a one-, two-, or four-row machine. The rows are 20 to 24 inches apart, usually 22 inches under Mississippi Valley and eastern conditions and 20 inches in the West.

The rate of planting varies from 12 to 20 pounds per acre, depending on germination and condition of the land. Usually 15 pounds per acre are planted. If the seed bed is moist, the seeds should be planted ½ to ¾ inch deep. If the seed bed is dry, they must be planted at a depth of 1 to 1½ inches in order to insure enough moisture for germination. The use of the cultipacker, after planting and before the beets are up, will often save a beet crop on ground that has a tendency to bake or crust over. As the so-called sugar-beet seed is in reality a seed ball containing a number of individual seeds, it is necessary to thin carefully by hand when the plants are young. Sugar-beet seed is usually supplied at cost by the sugar-beet company with whom the grower has a contract. Special efforts are made to secure seed of good germination, from strains that give a high yield and a high sugar content—an average of 13 per cent and above. Seed reduced to a single germ by mechanical processes is now available.

Fertilize Properly for Maximum Profits. Under average conditions, sugar beets respond best to substantial applications of a complete fertilizer that is high in phosphoric acid and potash. From 300 to 500 pounds per acre of a complete fertilizer, such as a 2–12–6 or a 4–12–4, give most profitable results. The bulk of the fertilizer should be applied during the preparation of the seed bed or should be broadcast and harrowed in just before planting. A smaller application of 100 to 125 pounds per acre may be applied in the row through a special fertilizer attachment on the seeder. It is a common practice, and a poor one, to apply a fertilizer of low analysis, in quantities that are not sufficient for maximum returns per acre.

Barnyard manure is one of the most valuable fertilizers for beets. Ample applications, 6 or more tons per acre, in the year previous to planting beets, give the best results. Spring applications immediately before planting beets are not recommended, since there is not sufficient time for proper incorporation with the soil, and short, prongy, low-yielding beets may result. The weed seeds carried in fresh manure greatly increase the cost of weeding. Only well-composted and well-rotted manure may be profitably applied in the spring. Manure should be supplemented with an application of 300 pounds of acid phosphate or of a fertilizer high in phosphorus and potash. (Note fertilizer recommendations, Chapter VII.)

Block and Thin to Strongest Plants, Properly Spaced. The largest yield of beets of the right size for highest sugar content results when plants are spaced 10 to 12 inches apart in the row. The solid row of young plants must be thinned to a single plant every 10 or 12 inches. When four leaves have developed on the young plant, the first cultivation, which comes very close to the row, is given. The plants are then blocked to tufts or bunches about 8 or 10 inches apart, with a sharp-bladed, 7-inch hoe or with a blocking-machine. The bunches are then thinned carefully by hand to one plant. *It*

is important that the strongest bunches be left in blocking and that, in thinning the bunches, the most vigorous plants be left in place. Careful attention to blocking and thinning will be repaid by a much more uniform stand and increased yield. Labor is usually paid on an acre basis; hence there is a tendency on the part of some workmen to pull the larger plants, which are easier to handle, and leave the smaller and weaker ones in place. The grower should give careful supervision to blocking and thinning, and it is usually advisable that a special bonus be paid to the laborers for an increase in yield over the average yield of the district.

Keep Beet Fields Well Cultivated and Free of Weeds. The first cultivation should be made as soon as the plants show plainly in the row, when two to four leaves have formed. This cultivation should be very carefully performed, since a good job greatly reduces the work of blocking and thinning. A week to 10 days after these operations, the second cultivation is given; and thereafter the crop is cultivated every week or ten days until the best leaves block the rows. Usually four to six cultivations are necessary. The first and second cultivations should be close to the plants and may be fairly deep between the rows, but later cultivations should be shallow, not more than 2 to 3 inches deep, so that the feeding roots of the beet plant, which tend to interlace between the rows after 35 to 40 days of growth, are not pruned. The cultivation of beets is best handled by the regular two- and four-row beet cultivator equipped with disk or knife weeders. Frequent and careful cultivation is necessary in order to secure good yields and high sugar content.

The first hoeing is given about 10 days after blocking and thinning, when the dirt is being carefully drawn about the plants but does not cover the crowns. This is followed by one or two hoeings at intervals of a week or 10 days to clear the weeds from between the plants. The careful grower cultivates close to the rows early in the season, taking out as many weeds as possible with machinery. He sees to it that the hoe-

ing is carefully done to get all weeds between the plants without thinning the stand by cutting out the plants. *The beet crop must be kept free of weeds.*

Harvest when Mature and when Sugar Yield Is Greatest. Since sugar beets make rapid growth and store most sugar as maturity approaches, they should be left in the field until the

H. C. Rather, Michigan Exp. Sta.

Harvesting sugar beets. The beet lifter raises the roots in the row and they are then pulled by hand, the dirt knocked loose, and the beets topped and piled in heaps.

right stage of maturity is reached. Proper maturity is indicated by the browning of the lower leaves and by a wilted or drooping appearance of the plants. Tests of sugar content are made by factory experts, and notice is usually given the grower when he should harvest. Harvesting generally begins in September and continues through October and into November, although in parts of California beet harvest may be begun in July. A special harvesting implement is used to raise the beets in the rows.

Top and Haul Immediately or Cover Heaps with Tops. After being lifted, the beets are pulled by hand; care should be taken to knock off clinging dirt by striking the beets together, a bunch in each hand. The usual practice is to throw

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the lifted beets into piles, and the topping is done from the heap so collected. A heavy knife is used in topping; the crowns are cut off at the base of the first leaf, or slightly above the sun line. The topped beets are thrown into heaps and covered with tops to prevent excessive loss of moisture. As soon as possible, they should be hauled to loading stations or factories to prevent drying and freezing, since repeated freezing and thawing make sugar extraction difficult.

It is important to both grower and manufacturer that beets be carefully topped. The crown and leaves of the sugar beet are relatively high in potash and phosphoric acid. If they are retained on the land or used as feed on the farm, much of the mineral fertility contained in the beet top is returned. The salts contained in the crown prevent proper crystallization in the process of sugar manufacture; hence manufacturers are fully justified in making deductions for the amount of tare due to poor topping.

Average yields per acre range from 8 to 10 tons, but good growers frequently secure 12 to 14 tons, and exceptional yields range from 15 to 18 tons.

Grow Beets in a Carefully Planned Rotation. The sugar-beet crop is a valuable one in the rotations of regions adapted to it. The production of a good crop of beets requires thorough preparation of the soil and careful cultivation; thus weeds are controlled, and the land is left in excellent condition without the need of plowing for a following crop of oats, barley, spring wheat or, if the beets are harvested sufficiently early, rye or winter wheat. If the tops are returned to the soil, or manure from feeding the tops and pulp is applied to the land, less of the mineral elements of fertility is removed from the soil by beets than by any other cash crop grown in sugar-beet regions. As a cash crop sugar beets are among the most profitable, but they require a large amount of hand labor and ample provision for the proper handling of the crop.

It is usual for beets to be grown after corn, beans, or potatoes, all of which leave the land comparatively free of weeds.

Clover sod plowed in the fall can be put in excellent shape for beets by proper fitting in the spring. Alfalfa or grass sods should be followed by a season of corn, beans, or any other cultivated crop before beets are planted, because of the expense involved in keeping down voluntary alfalfa, weeds, and grass. In Michigan, Wisconsin, Ohio, and Indiana, sugar beets are usually grown in the following rotations:

A. (1) Clover; (2) corn, beans, or potatoes; (3) beets; (4) oats, barley, or rye seed to clover.
B. (1) Corn, beans, or potatoes; (2) beets; (3) oats or barley seeded to alfalfa; (4), (5), (6) alfalfa.

In Colorado and Kansas, cantaloupes, cucumbers, potatoes, and canning crops, such as peas, beans, and tomatoes, may be included in rotation with beets, small grain, and alfalfa.

It is not good practice to grow beets year after year on the same land. Not only is fertility depleted and the organic content of the soil reduced but also great loss must be expected from fungus diseases, such as leaf spot, and from insect injury, particularly the root nematodes. Growing beets in a proper rotation effectively controls most of the insect pests, such as cutworms, white grubs, wire-worms, beet-root aphid, root nematodes, and minor pests. Rotation is the only practical way of controlling leaf spot, the fungus disease which causes the greatest loss in beet growing.

Tile-Drain to Increase Yields and Insure Crop in Wet Seasons. On poorly drained soils, a poor stand of prongy, short-rooted, high-crowned beets results. The water table should be sufficiently deep to permit the growth of well-formed beets of high sugar content.

Tile drainage lowers the water table and keeps it at a fairly uniform level. The cost of tiling is rapidly repaid by the larger yields of sugar beets which result. During wet years, serious loss occurs on untiled land throughout the humid sugar-beet regions. In the irrigated regions of the West, tiling is frequently necessary to reduce alkalinity.

Apply Lime where Needed. On acid soils, sugar-beet refuse lime, used at the rate of 2 to 4 tons per acre, or 1 or 2 tons of finely ground limestone, applied in rotation when seed beds for corn or beets are being fitted, will directly increase beet yields and markedly increase the yields of clover and alfalfa following in rotation; thus a greater residue of organic matter and nitrogen is supplied, and both the fertility and structure of the soil are improved.

Refuse lime can be secured from the beet-sugar factory. This lime contains 50 to 80 per cent of calcium carbonate and small percentages (less than 1 per cent) of nitrogen, phosphoric acid, and potash. It is excellent for the correction of soil acidity and has a slight, though appreciable, fertilizing value. In hauling beets to the factory, wagons should return loaded with refuse lime for later application.

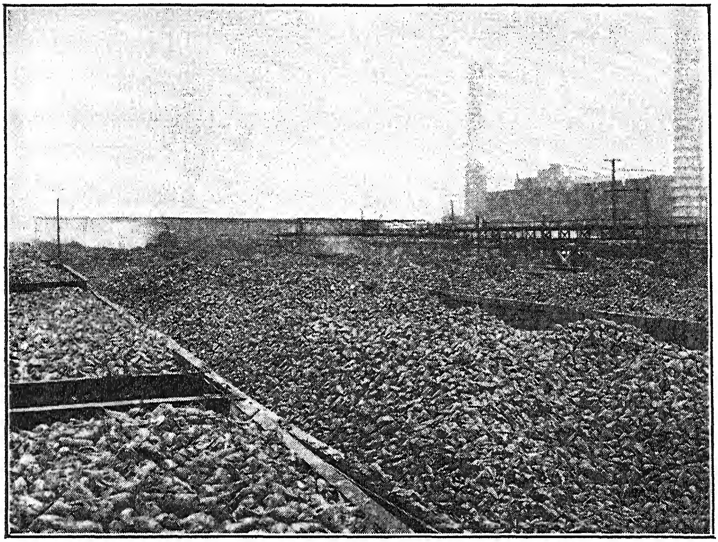
Feed Tops, Leaves, and Sugar-Beet Pulp. Beet tops and leaves furnish excellent feed for livestock. When left on the ground they may be profitably pastured by cattle and sheep. Until animals are accustomed to the feed, they should be turned on the field for short intervals covering a period of several days. If fed judiciously, a large part of the ration can be made up of tops and leaves without causing scouring. A more economical method of using tops and leaves is to ensile them in well-drained pits, 2 or 3 feet deep; a foot of straw is placed in the bottom, a foot of tops and leaves thrown in, and straw and tops placed in alternate layers; the heap is covered with a foot or more of straw and enough dirt to keep the pile from freezing. One-third of the ration fed to dairy stock, or one-half of the ration fed to fattening steers, may be made up of beet tops and crowns.

Under western conditions the tops are occasionally cured in the field and stacked like hay, though considerable loss of leaves is experienced when they are handled in this manner.

A valuable concentrated feed for dairy cows is made from dried beet pulp. Near the factories, this pulp may be fed in a wet condition.

Additional Information

Seed Production in America. Before World War I, practically all sugar-beet seed was imported; most of it was the Kleinwanzlebener or Vilmorin variety, produced in Germany. With the cutting off of the foreign supply during the war, the



Michigan Exp. Sta.

Sugar beets at plant awaiting manufacture, Bay City, Michigan.

home production of sugar-beet seed became important, and many western beet-sugar companies grew a large part of their seed. In Michigan, also, the production of sugar-beet seed developed on a large scale; several companies produced half or more of the seed used.

Recent developments in breeding methods by the U.S.D.A. have greatly expanded sugar-beet seed production in the United States, particularly in western producing regions, where disease-resistant strains are in great demand.

Good sugar-beet seed must not only be of high germination,

and from high-yielding strains, but must be produced from strains of beets carefully selected for high sugar content.

In the production of sugar-beet seed, the first step is the selection of mother beets of high sugar content which will produce progeny equally high in sugar. A great number of beets are analyzed, and the best individuals are carefully stored in moist sand. The following year these are planted separately, and seed from each plant is preserved and planted the third year in numbered plats. A remnant of seed of each is retained. The progeny of each strain is analyzed, the poorer strains are discarded, and the good ones are used in the production of mother seed which is increased in sufficient quantity for planting on a large scale.

In the planting of beets for commercial seed purposes, about 8 pounds of seed are used to the acre, in rows 18 inches apart. The plants may be thinned to 3 or 4 inches apart or left unthinned to save labor. The stecklings, as the small beets produced are called, are stored in moist sand protected from freezing by layers of straw and earth with ventilators every few feet along the top of the heaps. Early the following spring, the mother beets are planted in fall-plowed land, in rows 30 to 36 inches apart, with the beets the same distance apart in the rows. A spade is pushed into the ground and thrust forward, the mother beet inserted, and the earth pressed around so that the crown is slightly covered. Weeds are kept in check by thorough cultivation and hoeing. At harvest time, the seed stalks are cut with a sickle and piled in the field to cure for threshing with an ordinary grain separator. Yields of 800 to 1800 pounds per acre can be expected. At the Utah Experiment Station an average yield of 1461 pounds of seed per acre was reported for a 6-year period.

During World War II American sugar-beet seed production had developed to the extent that all domestic needs for increased production were provided for and sufficient American-grown sugar-beet seed was available to take care of the needs of Great Britain.

Beet-Sugar Manufacture. After harvest, the sugar beets are hauled from the fields to collection stations or to the sugar factory. At the factory they are stored in large heaps and in bins. The first step in the process of manufacture consists of the removal of all dirt by washing. Then the thoroughly clean beets are weighed and passed through a slicing machine which cuts the beets into thin strips termed cossettes. The cossettes pass on to iron cylinders or diffusion batteries, where they are subjected to a continual flow of warm water which removes the sugar by diffusion from the thin slices. The beet juice then passes to the carbonation tanks, where it is treated with a caustic lime solution and carbon dioxide, which purify the juice and cause impurities to settle to the bottom and leave a clear liquid. The pulp left is crushed or dried; it makes a valuable stock feed. The liquid is then filtered, retreated with a small amount of the lime solution and carbon dioxide, and again filtered. The alkalinity caused by the lime is then reduced with sulphur fumes; the juice is again filtered and is in condition for evaporation. It is evaporated by heat in a partial vacuum. When about half the water is removed from the juice, the sulphur treatment is again applied, and the juice is filtered. This thick juice is then passed through the vacuum pan, and moisture is removed to the point at which crystallization occurs. The mixture of crystals and syrup, known as massecuite, is put through a centrifugal machine which throws out the syrup. The sugar is then dried and sacked for market. A beet-sugar factory represents an outlay of capital of one to three million dollars. The average operating season ranges from 2 to 3 months.

Growing Root Crops. The growing of root crops for feeding dairy cattle and livestock in general is important in the Northern States and Canada. Some farmers feed roots instead of ensilage, but many grow a half-acre or more of roots to feed along with ensilage as a conditioner. Dairymen find the addition of root crops to the regular ration an excellent

means of increasing milk flow. The tonic effect of carrots upon horses is well known.

Dairy cattle on test or on exhibit at shows are kept in excellent condition if they are fed roots. Silage cannot be transported and kept in condition, as roots can.

Mangel-wurzels, or mangels, are the roots most commonly grown for this purpose. Usually 10 or 12 pounds per acre are planted in May on a seed bed fitted as for beets and cultivated in the same manner. The rows should be 24 to 30 inches apart. After the crop is up, it should be thinned to plants every 8 to 12 inches.

The mangels are harvested with a beet lifter or pulled by hand when they are mature. They should be stored in a well-made pit or root cellar.

Large table beets are also used in the same way.

Rutabagas are planted in May or early June in rows 22 to 30 inches apart, 2 pounds of seed per acre. They are given clean cultivation and harvested in the fall for storage in root cellars and for later feeding.

Cow-horn turnips are often broadcast in oats, 1 or 2 pounds per acre, and the turnips are pastured with sheep or hogs, after the oats are harvested.

Carrots are planted in rows 28 inches apart, 4 pounds of seed per acre on a well-fitted seed bed, in May or June, and given clean culture. They start slowly, and hence careful fitting of the seed bed and early and thorough preparation are necessary.

SUGGESTIONS

1. What is the acreage of sugar beets in your county? In your state? Compare acreage with other cultivated crops.

2. On what soils are the best crops grown? The poorest crops? What is the average yield of your county? Do you know growers in your neighborhood who get larger yields? When do these growers plow? Describe their methods of fitting seed beds, planting, and cultivating. Secure similar information for growers securing average or less-than-average yields per acre.

3. What is the usual contract price? Total price received? Determine approximately the cost of producing an acre of beets yielding 10 tons; 15 tons; 5 tons. Approximate net profits or net loss in each case.

4. Do beets fit well in the rotations of your community? Are beets grown by dairymen and livestock producers? What are the advantages and disadvantages of the sugar-beet crop?

5. Discuss the desirability of the production of a larger percentage of home-grown sugar from the sugar beet in the United States.

6. Visit local fields in the fall and note harvesting and handling methods. On what kind of soil are beet crops grown?

7. Ask leading growers about methods of handling their crops. Are tops fed? How?

8. If you are near a beet-sugar factory, arrange a visit while it is in operation.

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CHAPTER XXXIII

GROWING SPECIAL FIELD-TRUCK CROPS

On many farms the growing of special cash crops adapted to soil conditions and market demands may be included in the general farm program to great advantage.
DEAN C. E. LADD

On many farms located near good marketing centers or canning factories, the inclusion of vegetable crops as cash crops in the farm rotations is profitable. The growing, on a field scale, of cabbages, tomatoes, sweet corn, onions, carrots, peas, and beans for the market or for canning or pickling will, under adapted conditions, add greatly to the farm income. Sweet corn, peas, and beans contribute to the supply of roughage for livestock. A careful study of market needs and soil and climatic adaptation will often make it possible to add a highly profitable crop to the farm enterprises.

Cabbage Growing.[1] The work of modern dietitians, emphasizing the value of cabbage in the diet, and the recent demand for sauerkraut juice have greatly increased the consumption of cabbage.

The cabbage plant requires for its best development a cool, moist climate and fertile moisture-retentive soils, well supplied with organic matter. Rain and cool weather are beneficial. Although cabbage of high quality may be produced on hillside soils of average fertility, the yield is usually less than on more fertile land. The crop does not do well on sandy or heavy clay soils. Loams, silt loams, and clay loams of lime-

[1] Prepared with the assistance of Dr. C. E. Ladd, Dean of Agriculture, Cornell University.

stone or alluvial origin make the best cabbage soils. Muck soils are often excellent cabbage soils.

Cabbage occupies the same place in the rotation as other hoed or cultivated crops grown on a field scale.

New York

A thrifty, well-cultivated field of cabbages.

1. Grow variety best suited to soil and market conditions.
2. Start young plants in seed bed for transplating.
3. Prepare ground as early as possible.
4. Plant at right time.
5. Fertilize for added profit.
6. Keep crop free of weeds.
7. Harvest when mature.
8. Market from field or store for later market.

Grow Variety Best Suited to Soil and Market Conditions. There are five distinct types of cabbage under cultivation:

(1) Flat Dutch, or Drumhead; (2) Conical or Pointed Head; (3) the Savoy; (4) the Red; (5) the Danish or Hollander Ball Head. Within these groups there are a great number of varieties. The Flat Dutch varieties are generally used for sauerkraut. The Danish are the leading market varieties, owing to their excellent keeping qualities.

Start Young Plants in Seed Bed for Transplanting. The seed bed should be ground which has not grown cabbage, turnips, or radishes for a number of years, to lessen the possibility of loss from club root. Usually the seed bed is located in one corner of the field to be planted.

The seed bed should be plowed and fitted as for the regular crop, but extra care should be given to the final fitting. Usually about 1 pound of seed is planted for every 2 or 3 acres of cabbage. Seed beds for late cabbage are planted from May 1 to May 20. The early-planted beds suffer most from root maggot; hence most beds are planted about May 10.

The seed is generally planted broadcast and brushed or harrowed in. For 1 acre of transplanted cabbage, about 5 to 8 square rods are needed in the seed bed. About 3 or 4 pounds of a high-grade commercial fertilizer should be applied per square rod when the seed bed is fitted. An application of lime with the fertilizer is beneficial. The seed may be mixed with the fertilizer for broadcasting and harrowing with weeder or brush drag.

The seed bed for early cabbage, or for cabbage raised for sauerkraut factories, is handled in a different manner. It is planted considerably earlier, from April 10 to May 1. The seed bed should be very carefully prepared and screened to prevent loss from the cabbage-root maggot.

The corners of the bed should be staked so that a frame can be made and a cheesecloth screen applied before the plants come up.

The seed are drilled thickly in rows 6 inches apart. A framework of 8- or 10-inch boards is made around the bed, and cheesecloth is stretched over the frame before the plants

are up. Wires should be stretched over the frame 4 or 5 feet apart to hold the screen.

Prepare Ground as Early as Possible. Fall-plowed or early spring-plowed land should be fitted thoroughly as land is fitted for corn. A well-compacted seed bed with surface in a fine condition of tilth is necessary. Transplanting on small acreages is done by hand, with a trowel, and the plants are set in check marks made by a marker. Machine planters have come into general use. Rows are usually 3 feet apart and plants 18 to 24 inches apart in the row.

Plant at Right Time. The time of setting varies with the purpose for which the crop is grown. If it is for sauerkraut, the plants should be set in early June. Late cabbage should be set in late June or early July.

Fertilize for Added Profit. The cabbage crop responds to heavy applications of high-grade fertilizer, such as a 5–10–5, used at the rate of 400 to 500 pounds per acre. Manure used in connection with commercial fertilizer or alone gives excellent results when applied either for the cabbage crop or for a previous crop.

Keep Crop Free of Weeds. Ample time is allowed for a good job of weed killing at the time of the fitting of the seed bed, since cabbage plants are usually not transplanted until late June.

Cultivation begins immediately after transplanting. Cultivations are given every week or ten days until the plants begin to cover one-half or two-thirds of the ground.

Level cultivation should be practiced, and hand hoeing resorted to if necessary to control troublesome weeds not removed by ordinary cultivation.

Harvest when Mature. For sauerkraut factories, cabbage is harvested from the latter part of August until winter begins; the work is distributed over a period of two months or more.

The Danish cabbage for the market is harvested in late October or early November.

Harvesting is much the same for either purpose. The

heads are cut from the stump, and the loose outer leaves are trimmed off. If this is done in one operation much time is saved. In cutting cabbage, round-pointed shovels, hatchets, butcher knives, corn knives, and straightened hoes are commonly used by various growers.

The most efficient cutter is a long-handled form with two tines projecting about 6 inches and a thin strap of steel with a sharp cutting edge riveted across the tines. Very little trimming is needed if this cutter is properly used. The blade is drawn backwards across the cabbage head with a downward motion, which draws outer leaves away from the head and presses them down out of the way. Then the blade is dropped below the head and given a quick forward thrust which separates the head from the stump. This implement can be made by a blacksmith from an old fork and piece of scythe blade, or it can be purchased.

As the cabbages are cut, they are trimmed and thrown into rows. The heads are then loaded into a wagon and hauled to the storage house, car-loading station, or kraut factory.

Market from Field or Store for Later Market. Cabbage must be marketed from harvest time to late March. Prices fluctuate greatly, and the crop is a speculative one. In years of overproduction cabbage is fed to livestock. It makes an excellent feed for dairy cows.

Cabbage is commonly stored in heaps on sod ground and covered with straw or hay. There is usually a large shrinkage due to rot and freezing. If weather continues uniformly cold the shrinkage may be as low as 10 per cent. If warm weather periods are frequent, it may go as high as 50 per cent.

In arranging heads for field storage, they are laid, stump down, on sod ground in single layers, or layers several heads deep, closely crowded, and covered with straw or hay. Swale hay is generally used.

Cabbage is also stored in storage buildings or cellars by dealers and large growers.

The heads are piled in large continuous piles of not too

great depth, or in long bins about 3 feet wide and as deep as space permits. Good ventilation is important.

Cauliflower and Broccoli. Cauliflower and broccoli are descended from the wild cabbage; they differ from cabbage in that the flower parts are used instead of the leaves. They are subject to the same diseases and insects as cabbage. Similar practices in the starting of young plants in seed beds, preparation of ground, fertilizing, planting, and cultivating as recommended for the handling of the cabbage crop apply in the main to these crops.

General Information

Chief Insect Pests and Diseases. The cabbage louse or aphid, cabbage worm, and cabbage maggot are the most troublesome insect pests. The late Professor R. H. Pettit (Michigan Experiment Station) states the following in regard to these insects and their control:

The Cabbage Aphid (*Aphis brassicae*). From mid-summer until fall, cabbages are subject to attack by plant lice. Of course the lice are present earlier in the season but in such small numbers that they escape detection. Both winged and wingless forms occur, all of them being covered with coats of fine waxy powder, very much like the bloom on the leaves of the cabbage on which they rest. This waxy bloom no doubt serves as a protection by helping to conceal the insect, but when we come to spray we find that it helps very effectually to repel the liquid. Lying as they do in closely packed colonies, which sometimes cover almost the entire underside of a leaf, they should be killed with ease, one would think. One finds, however, on trying to kill them, that most spray mixtures slide from them like water from a duck's back. Furthermore, it is very difficult to reach them when they are under the foliage. In order to overcome this last difficulty, we have used a short extension, about 3½ feet long, with a Vermorel nozzle set at right angles to the extension. This makes it easy to reach the undersides of the leaves, and by simply turning the extension in the hand one can spray downward on the head of the cabbage.

The best spray for the lice is made by diluting 40 per cent nico-

tine sulphate (Black Leaf 40) with water, and adding considerable soap. Use one part of the nicotine to 800 of water, and to every barrel of the mixture add 2 or 3 pounds of soap. The difficulty will lie in hitting all the lice, and the lice must be hit to be killed.

Dusts of nicotine may be used instead of a spray and with good results.

The Cabbage Maggot. Cabbage plants and cauliflower plants stand a much greater chance of escaping the attacks of root maggots if protected by disks of tarred paper when first set out. The adult flies dislike the tarred paper, and lay their eggs elsewhere.

Cut tarred building paper into circles or squares 2 or 3 inches across. Punch round hole about ¼ inch in size at center and cut a slit from the hole to one side. A large harness punch and a pair of tinsmith's shears will aid in doing a rapid job. These disks can be bought in quantity ready for use.

Place disk so stem of cabbage plant comes up through hole in center and press down flat to soil when setting out the plants. Ninety per cent immunity can be secured under conditions where unprotected plants are practically all lost.

Cabbage Worms (Pieris rapae). "Common as white butterflies." We see them fluttering wherever there are plants of cabbage, cauliflower, rape, radish, turnip, mustard, or any member of the mustard family. There are three species found in the North: two native species, the northern white and southern checkered white; and the imported white cabbage butterfly, which in numbers and in most localities surpasses both of the other species.

The yellow species of about the same size is not to be confused with the "whites," since its caterpillar feeds on clover and not on plants of the mustard family. One sees the white butterflies laying eggs on cabbage and its relatives, and soon afterward the well-known green or bluish-green larvae are to be found on the plants, where they are commonly called "cabbage-worms." They eat holes in the plants, sometimes tunneling quite deeply into the heads, and changing to naked pupae, which are fastened by loops of silk to the under sides of leaves or on nearby objects. In a few days or weeks, these pupae, in turn, give rise to some winged butterflies, except of course, in the case of the over-wintering generation. Both adult butterflies and "worms" or larvae are to be found at almost any time during the growing season.

The list of killing agents used against cabbage worms is a long one. In earlier times, soot, air-slaked lime, road-dust, cheap flour, and many other dusts were used. Hot water had its day, and kerosene emulsion, to which has been added a little pyrethrum, is still used by some growers. The writer has, in the past, recommended several of the agents mentioned, but is now recommending other remedies—not that either hot water, or kerosene-emulsion will fail to kill, but because it is laborious to use hot water and dangerous to the plant, and because kerosene-emulsion is an abomination to make and moreover taints the cauliflower and cabbage if used late in the season.

Before the cabbage heads-out very far, use arsenate of lead dust or spray. Put on in the ordinary way, and after the heads form well, use hellebore and hydrated lime, or hellebore and cheap flour—about one part of the poison to three or four of plaster, lime, or flour. The reason for the use of hellebore instead of arsenate of lead is merely that it is an organic poison whose effect is less permanent. The danger in eating the vegetable is thus greatiy reduced, the poisonous principle of the hellebore breaking down on exposure to the weather.

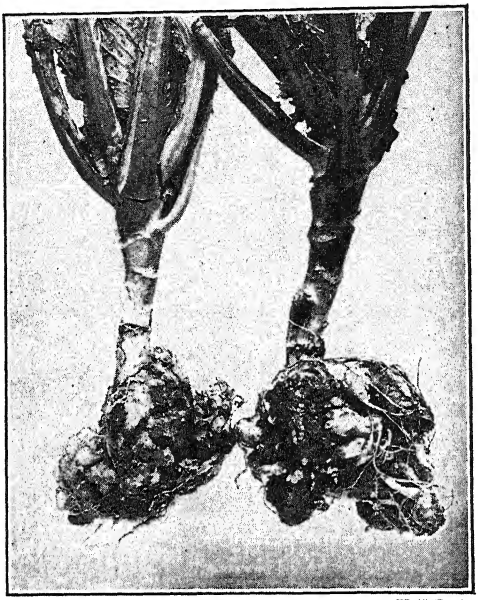
Cabbage Diseases. The club root and black rot are the most injurious cabbage diseases.

The club root, or club foot, is a destructive fungus disease which causes seedlings to show a decided "flagging." They become stunted and unhealthy, and generally die. The parasite enters the root of the cabbage plant and stimulates an abnormal growth which results in striking malformations.

Liming is the most effective control method. Cabbage is seldom affected on soils well supplied, naturally or artificially, with lime. No refuse from old cabbage fields should be spread where cabbage is to be grown, or mixed with manure piles to be applied on cabbage ground. Rotation of crops and destruction of mustard, which harbors the parasite, should aid in control.

Black rot is one of the most destructive and least controllable of cabbage diseases. Infection is greatest during spells of warm days and cool nights and damp weather.

Affected plants show a yellowing of the leaves, and the veins and edges show brown or black; young plants are killed and older plants ruined for the market.



U.S.D.A.

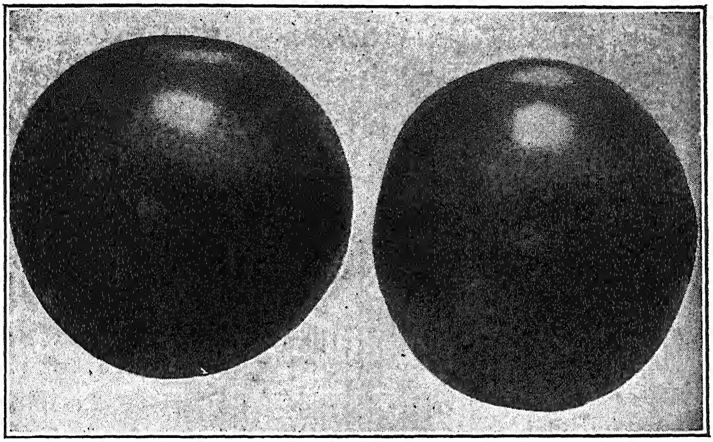
The club root of cabbage. This disease is controlled by sterilizing plant beds and growing cabbage in rotation on well-limed fields.

Rotation of crops helps in preventing injury from black rot. Seed treatment using mercuric bichloride (*poison*), 1 to 1000 of water for fifteen minutes or formalin 1 to 200 for twenty minutes is effective.

Growing the Tomato. The tomato is one of our leading vegetable crops, and no vegetable is served in a greater variety of ways. With the growth in knowledge of the importance of vitamins and the widespread popularity of tomato juice, the use of the tomato has greatly increased. The crop is widely adapted from the standpoint of climate and soil. The following operations are effective in giving the best results with the tomato crop.

Choose Varieties of Highest Yields and Best Quality. Leading market garden varieties are the Marvel (wilt-resistant), John Baer, Earliana, Bonny Best, and June Pink. Leading

canner varieties are the Norton (wilt-resistant), Marglobe (wilt-resistant), Greater Baltimore, Stone, John Baer, and Bonny Best. New and improved varieties of great wilt resistance, yielding ability, and uniformity include the Prichard of the United States Department of Agriculture, the Sioux of the Nebraska Experiment Station, and the Rutgers of the New Jersey Station.



The tomato has increased greatly in importance with the gain in the public knowledge of the value of tomato juice, canned tomatoes, and raw tomatoes as sources of vitamins and mineral salts.

Grow Strong Plants. The seed should be planted in sterilized seed beds, in cold frames, or in hot houses. The soil should be treated with steam or hot water if facilities are available. Clean soil that has not previously grown tomatoes or related crops is highly desirable, and if it is available sterilization may not be necessary. Before transplanting, the greenhouse ventilators are opened or the tops of the cold frames are raised to harden the plants.

Plant on Clean, Fertile Loam or Clay Loam Soils. Losses from disease are greatly reduced if tomatoes are planted on

clean ground in rotation. They must be fertilized with complete fertilizer. Tomatoes respond to applications of ample amounts of fertilizer high in phopshorus. Usually 400 to 800 pounds of a 6–12–6 or a 4–16–4 fertilizer are used.

Transplant when Soil Is Warm. Standard varieties are usually planted every 3 feet in rows 4 feet apart, and smaller varieties every 3 feet in rows 3 feet apart. Transplanting should be delayed until danger of frost is past.

Give Frequent Shallow Cultivation. These are necessary at intervals of a week or ten days until vines interfere.

Spray with a 4–4–50 Bordeaux Every Two Weeks. This spray will control septoria leaf spot and blight (*Phytopthera infestans*). In 1946, blight ruined half the tomato crop in the Eastern Shore areas of Maryland and Virginia. Tomatoes should not be planted after, or near, potatoes as a precaution against blight. If a large acreage is grown a large power sprayer should be used.

Make First Picking when One-Third or More of Crop Is Ripe. Market only sound well-matured fruits. The second or later picking should be made when necessary to prevent decay, or in accordance with market demands and rapidity of maturity.

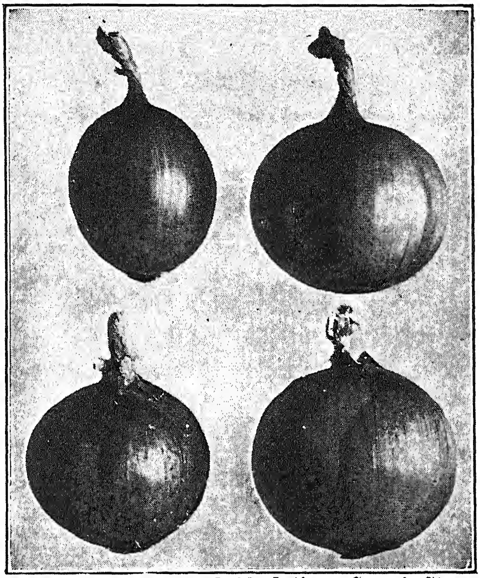
Growing Onions. The onion ranks fourth or fifth in importance as a vegetable crop in the United States. It is adapted to a wide variety of soils and climate. The onion is in demand both in the form of bunch onions and when ripe. It may be grown from seed or from sets. The commercial crop is usually grown from seed.

Choose Best Varieties. Yellow varieties are most important commercially, and the most important of these are the Yellow Globe Danvers, Southport Yellow Globe, and Ohio and Michigan Yellow Globe. Of the white varieties the Silver Skin, the Southport White Globe, and the White Portugal are leaders.

Select a Loose Fertile Soil Retentive of Moisture. Silt loams well supplied with organic matter or muck soils are best

adapted to growing onions. The seed bed should be finely prepared and all trash removed that might interfere with the cultivation.

Fertilize Heavily in Accordance with Soil Needs. On muck soils complete fertilizers high in potash are advised, such as



Seed Production and Marketing—Cox & Starr

Types of Globe Onions. Upper left, Southport Yellow Globe; upper right, Yellow Globe Danvers; lower left, Southport White Globe; lower right, Michigan Yellow Globe.

a 2–10–10. On loams and silt loams a complete fertilizer, such as a 6–12–6, is usually employed. From 400 to 800 pounds per acre should be applied.

Sow the Seed in Drills. The seed should be sown 14 inches apart for hand cultivation and 18 to 24 inches apart for horse cultivation, 3 to 5 pounds per acre. Seed should be sown early in the season when danger of hard frost is past.

Give Frequent Shallow Cultivation. Cultivation should be started when the plants first show above the ground. Hand weeding should be employed when necessary. Onions should be harvested when mature, as evidenced by the breaking over of the tops and the mature appearance in the bulbs. They should be cured in the field, and the tops should be removed in preparation for sale or storage.

Carrot Growing. Carrots have long been an important vegetable, but during recent years the use of sliced raw carrot has greatly increased the demand for this crop. Public education in regard to the value of raw carrots because of their vitamin content, particularly carotin, is responsible for this new demand. The carrot may be grown over an extensive range of territory.

Choose Highest-Yielding Varieties of the Best Quality. The most important market varieties are the Chantenay and Danvers half-long types. The Nantes, a slender, cylindrical type, is a leading garden variety. The Long Orange, a pointed root type, produces a heavy yield and is grown largely for livestock feeding.

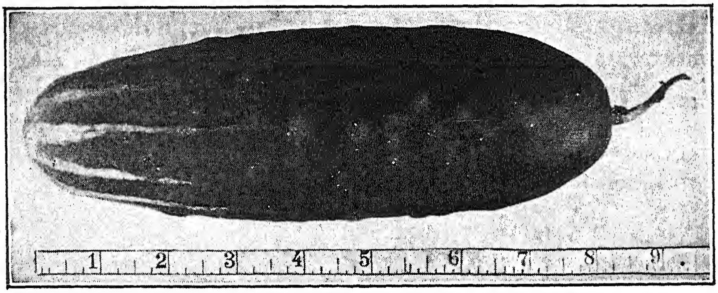
Carrots should be planted on a rich silt loam or muck soil. The seed bed should be fitted thoroughly and fertilized with 300 pounds or more of a high-grade complete fertilizer per acre. Carrots should be planted in early summer when the ground is well warmed. About 2 or 3 pounds of seed per acre are drilled in rows 14 or 18 inches apart. Carrot seeds germinate slowly and, in order to start cultivating before weeds grow profusely, many carrot growers plant a small amount of radish seed to mark the rows.

Cultivation should be frequent and of shallow depth. The plants should be thinned to 2 or 3 inches apart in a row, and the rows should be hand-weeded when necessary to control weeds.

Crops should be harvested before frost, marketed, and stored in well-ventilated storage cellars. A yield of 2 or 3 bushels per acre is considered good.

Growing Cucumbers. The cucumber has been grown by man for more than 3000 years. Its use has never been more important than at the present time, not only for its content of vitamins and mineral salts but also because a great variety of pickles, salads, and relishes are valued as appetizers.

The leading commercial varieties of cucumbers are the Boston pickling and the Chicago pickling varieties. These are black-spined varieties that mature in mid-season. The Davis



A uniform type of cucumber.

Perfect, earliest of all, and the Early Fortune are important truckers' varieties. For small pickles the Early Cluster is widely grown. The Long Green Improved is widely grown as a slicing variety.

Cucumbers should be planted on a fertile loam, silt loam, or a sandy loam soil. The ground should be plowed early and thoroughly fitted and fertilized with manure, with an application of 400 pounds or more of complete commercial fertilizer per acre.

The seed should be treated with corrosive sublimate solution, or other effective disinfectant, to control seed-borne diseases. Planting should start when the ground is well warmed and the danger of frost is past. The seed is planted in hills, 4 by 4 feet apart, at a depth of ½ inch, 6 or 8 seeds per hill.

Cultivation should start as soon as the plants show in the row. When the plants are established, they should be thinned

to three or four plants in a hill. The striped cucumber beetle and twelve-spotted beetle are controlled by dusting with calcium arsenate and gypsum, or with a 4 per cent nicotine dust. These dust treatments are applied as soon as the plants appear above the ground.

Harvesting should begin in accordance with the market demand. Small pickles are frequently in demand for family pickling. Pickles of various sizes are bought by commercial pickling firms. Many find a market for full-sized cucumbers.

Growing Muskmelons. Properly grown and high-quality muskmelons offer an excellent marketing opportunity in many localities. The buying of muskmelons is still a lottery in most markets, and the grower who can produce a uniform product of high quality by superior selection and improved cultural methods is assured of a strong demand.

The selection of the variety is most important. For shipment to long distances the Rocky Ford type is recognized as a leader. The green-fleshed varieties generally grown are the Eden Gem and the Extra Early Knight. The salmon-fleshed varieties of the Rocky Fords are represented by Hearts of Gold, Rice's Orange Flesh, Perfecto, and Defender. For local markets large varieties such as Osage, Bender's Surprise, and Tip Top are most popular.

Muskmelons do best on well-drained sandy loam or silt loam soils. Manure and 300 pounds or more of a high-grade fertilizer should be used as a fertilizer. The seed should be disinfected with corrosive sublimate as recommended for cucumbers and planted when the soil is well warmed. Planting in hills, spaced 5 by 5 feet apart, is usual. Fifteen or twenty seeds are dropped per hill. As soon as the plants appear aboveground they should be treated to prevent injury from the striped beetle, with 5 per cent calcium arsenate in gypsum, or 4 per cent nicotine-impregnated dust.

Frequent shallow cultivation should be given from the time the plants first appear above the ground until the vines meet

between the rows. The plants should be thinned to three or four plants in each hill when the second leaf develops.

Muskmelons should be harvested when fully ripe. Usually two or more pickings are necessary.

SUGGESTIONS

1. Visit farms of leading growers of cabbage, onions, sweet corn, and so on, in the fall at harvest time. Note methods of harvesting. Consult leading growers regarding varieties, methods of handling seed beds, and cultural methods.
2. Visit a local storehouse, cannery, or kraut factory. Note storage methods and manufacturing methods.
3. What are average yields of field-truck crops secured? What are considered profitable returns per acre?
4. What special crops not grown locally might possibly be grown with a likelihood of profit?

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CHAPTER XXXIV

THE HOME-FARM FOOD SUPPLY. FOOD FROM THE GARDEN, FIELDS, WOODS, AND PONDS

The farmer should raise the food for the family and for the farm stock so that his principal cash crops shall be all profit.

SEAMAN A. KNAPP

Vegetables, fruit, milk, eggs, and meat can, with proper attention, be produced very economically on the home farm for use during the entire year. An ample supply of vegetables from the home garden provides a mixed diet of suitable variety. Much greater use will be made of these important foods if they are raised in quantity at home, and it will be unnecessary to buy them on the market. An ample garden provides not only a succession of fresh vegetables and fruits during the growing season but also furnishes a supply for canning, drying, and storing in root cellars or deep-freeze refrigerators for the winter season.

The feed crops, pasture, roughage, and grain for the dairy cows, poultry, hogs, sheep, or beef cattle produced for the farm family must be included in the general cropping system of the farm. Pasture ranges of bluegrass, ladino, clover, alfalfa, or other suitable pasture grown in rotation should be made available for the farm poultry flock, not only to provide ample pasturage and to reduce feed costs but also to control poultry diseases, which generally extract a heavy toll. If hogs, sheep, and beef cattle are produced on the farm for market, supplies for the family can easily be withdrawn, when needed, from the herds and flocks. If, however, hogs and sheep or an occasional beef animal are produced for family use only, careful

attention should be given to providing the needed pasture, hay, and grain feeds that will produce a balanced ration.

The efficiency and health of farmers, like those of all people, depend to a large extent on their diet. Farm families, with a little care in planning the program of farm production, may enjoy a varied and healthful diet without purchasing large supplies. Each day the diet should contain: tomatoes, citrus fruits, raw or slightly cooked vegetables such as cabbages, cauliflower, rutabagas; green and yellow vegetables, raw, cooked, frozen, canned or dried; potatoes, other vegetables, and fruits; milk and milk products; meat, poultry, fish, eggs; cereals, flour, bread; butter or various fats suitable for food.

Great emphasis has been placed upon balanced and proper diets for farm livestock. Experimental work has demonstrated that good crops from a nutritive standpoint depend upon soils which have been properly cared for and furnished with the needed elements of fertility. Thus a good diet for humans is at the end of a chain which begins with good soils. Good soils, good crops, good livestock result in good food materials for human diets.

From the standpoint of economy, the value of a properly managed home garden and farm flocks and herds for home use is considerable. Records show that time spent in the care of the garden and animals for a home-feed supply pays as great returns as hours spent on products for the market. From the standpoint of the foundation for wholesome living and the fine hospitality for which American farm life is famed, proper attention to the farm-produced supply of vegetables, meat, milk, eggs, poultry, and fruit can be estimated not as dollars and cents alone but as a splendid asset to farm living.

In periods of hard times, the farm families that possess a good garden, flocks, and herds for home use, and well-stocked cellar shelves and smoke-houses, are in a much better position to maintain their independence and often to increase their

income through sales of excess products than families that have not been so far-seeing and energetic.

Yet, on the average farm, the garden, small fruits, and home-produced meat and poultry are sadly neglected. The pressure of seasonal work and the ease of buying from the store cause many to forget the advantages in economy and

U.S.D.A. Extension Service

The farm garden contributes substantially to the family food supply.

health if farm operations include the relatively few hours needed to provide amply for the greater part of the food needs of the family.

The following are considered essential operations in managing the farm garden:

1. Select adapted land for the farm garden.
2. Apply manure and commercial fertilizer.
3. Irrigate to increase yields.
4. Prepare a thoroughly fitted seed bed.
5. Choose the best obtainable seed.
6. Control insects and diseases.

Select Adapted Land for the Farm Garden. For convenience the garden should be located near the farm home or should be included as part of the homestead. The small fruits, strawberries, blackberries, raspberries, and such perennials as rhubarb, asparagus, and pot herbs should be located where they are easily accessible. These crops at the rear or side of the homestead lend themselves well to the landscape program. Provision should also be made for a comparatively small, thoroughly worked, and thoroughly fertilized plot not too far from the kitchen door for the growing of radishes, lettuce, onions, and a few rows of peas, beans, and other vegetables that can be easily gathered. It is usually a mistake, however, to set aside a piece of land for a garden for annual crops year after year. Plant diseases carried in the soil, insects, and weeds cause increasing losses unless the plots are large enough to provide for a rotation of legumes and other green-manuring crops. It is much more satisfactory to select the acre or so needed for the bulk of the garden crops in a field devoted to cultivated crops in the main rotation program of the farm and to plant here the potatoes, tomatoes, sweet corn, beans, peas, squashes, pumpkins, and melons that are needed in quantity. The part of the main field devoted to the garden should be more thoroughly fitted, manured, and fertilized; if new ground is chosen each year for the major vegetable crops higher yields are secured and losses in yield, impairment of quality, and damage from many insect pests and plant diseases are largely reduced. If the garden is planted in long rows, it may be cultivated with tractor or horse and field equipment at the same time that the corn, potatoes, or other cultivated crops in the main fields are cultivated, the cost of cultivating will be greatly reduced, and the garden crops will be assured attention. The long-row garden is a great time saver.

Apply Manure and Commercial Fertilizer. The land for a garden should be well drained. Sandy loams and loams are preferred, but clay loams and clays that are lightened up by

the use of farm manure or the growing of alfalfa, clover, pasture grasses, or green-manuring crops often make excellent garden soils. The acre or two chosen from a field in rotation for garden use and the home garden plot should be fertilized with 8 or 10 tons of manure, well-rotted if available, and with 400 or 500 pounds of a high-grade complete commercial fertilizer such as a 5–12–6. Acid soils should of course be limed for the successful production of most garden crops. Southern, or southeastern, exposures are generally preferred, and if possible the garden should be located where proper air drainage lessens the likelihood of frost injury. A gentle slope facing south or southeast is ideal.

Irrigate to Increase Yields. If the garden can be located where a water supply is available for irrigation higher yields of better quality vegetables will result, and extreme damage from drought will be prevented. Irrigation water may be effectively applied either by the overhead sprinkling system or the lately developed porous-hose system, a system which, because of its low cost and practical adaptation, is gaining rapidly in farm use. The watering of transplanted crops, such as tomatoes, cabbages, peppers, sweet potatoes, and eggplants, is frequently necessary after the plants are set out. Water may be hauled in barrels or tanks to the field and applied with buckets or sprinkling cans. If, however, irrigation arrangements can be made, results will be more satisfactory.

Prepare a Thoroughly Fitted Seed Bed. The same principles apply to the fitting of the seed bed for the garden as to the preparation of the land for corn or other cultivated crops. A thoroughly surfaced seed bed, well compacted in the lower part of the furrow slice, is necessary. The land should be plowed to a good depth, 8 to 10 inches in the fall or early spring, and fitted with the disk, spike-tooth harrow, and cultipacker or roller. Greater attention should be given to the part of the field to be planted to garden crops; it should be gone over several extra times with cultipacker and harrows.

The cultivating equipment used in the cultivation of the corn crop may be employed in the cultivation of garden crops grown in the main field with corn.

The small garden plot included as part of the farmstead should be plowed early and deep, thoroughly harrowed, and packed with a roller or cultipacker. For the cultivation of this plot a small hand cultivator is often highly desirable; it is unnecessary to take tractors or teams from the field for the frequent cultivations that the small garden requires.

Choose the Best Obtainable Seed. Soon after the new year, seed catalogs burden the mails and bring color and interest to the reading table. The beautifully colored pictures of tomatoes, melons, pickles, beans, peas, and flowers should not be taken as sound guides in the choice of varieties and of sources of supply. These are generally furnished by illustrating companies and may or may not represent the actual seed and varieties described in catalogs. It is of the utmost importance that seed for the garden be purchased from dependable seed companies, of which there are many, whose dependability has been proved by experience in the locality. Much loss can come to the purchaser of cheap, inferior seed from unreliable sources.

As a rule, garden seed should be purchased from seedsmen of repute who guarantee their seed as to variety, germination, and purity. Varieties of garden crops adapted to particular localities should be secured. It is advantageous to buy seed that has been treated to control seed-borne diseases or to secure disease-resistant varieties, such as the Marglobe tomato or the Cornell wilt-resistant cabbage. Much expense can be saved if growing plants, such as cabbage, tomatoes, peppers, and lettuce, are set out in cold frames or window boxes.

Control Insects and Diseases. Mr. W. R. Beatty, Senior Horticulturist of the United States Department of Agriculture, states that anyone who plants vegetables or fruits nowadays without making definite plans for the control of insect pests

and diseases is headed for certain failure. Mr. Beatty classifies the standard remedies used in insect and disease control as follows:

Stomach Poisons

Paris Green

Spray

Paris green	2 level teaspoons	or	⅔ pound
Hydrated lime	6 level teaspoons		2 pounds
Water	1 gallon		50 gallons

Dust

Paris green	1 level teaspoon	or	1 pound
Hydrated lime or flour	1 pint		12 pounds

Calcium Arsenate

Spray

Calcium arsenate	6 level teaspoons	or	2 pounds
Hydrated lime	12 level teaspoons		2 pounds
Water	1 gallon		50 gallons

Dust

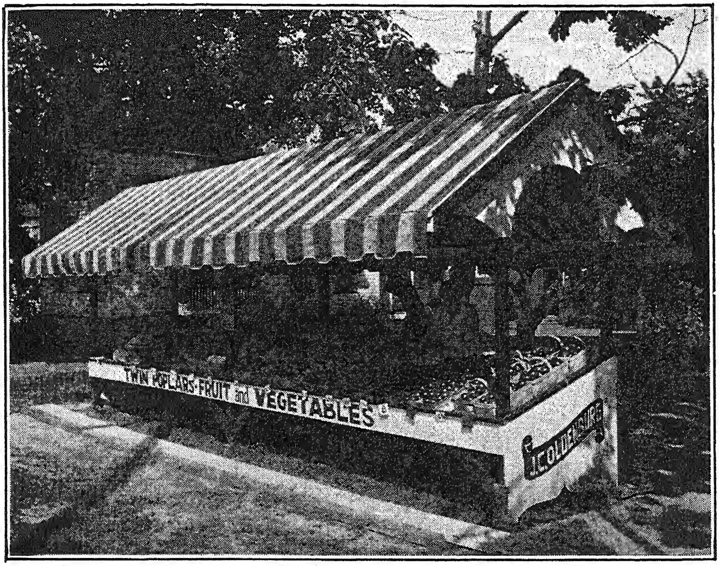
Calcium arsenate	2 level teaspoons	or	1 pound
Hydrated lime or flour	1 pint		7 pounds

Poisoned-Bran Bait

Paris green	2 level teaspoons
Wheat bran	5 pounds
Molasses	½ pint
Water	5 quarts

Mix the paris green and dry wheat bran together so that every particle of the bran will receive a coating of the paris green. Dissolve the molasses in the water. Add the liquid to the dry materials slowly and mix thoroughly, making a rather dry mash.

Scatter the bait thinly, about sundown, near plants to be protected. The worms crawl out at night and eat the poisoned bran. If the garden is to be planted where heavy vegetation grew last fall, it would be advisable to scatter bait over the entire garden just before planting.



Rochester, New York

An attractive roadside market stand built from inexpensive materials.

Contact Poisons

Nicotine Sulphate

Spray

Nicotine sulphate (40 per cent nicotine)	1 teaspoon	or	¾ pint
Soap, any kind	1 cubic inch		3 pounds
Water	1 gallon		50 gallons

Dust

Nicotine sulphate (40 per cent nicotine)	1 ounce	or	3¾ pounds
Hydrated lime	2 pints		50 pounds

Nicotine dust is most effective if applied when the air is still and the temperature high, preferably above 75° F. Nicotine dust must be very thoroughly mixed in order to secure a uniform blending of the ingredients and must be applied as soon as mixed or kept in a tight container to prevent the loss of the nicotine.

Fungicides (for Disease Control)

Bordeaux Mixture

Pulverized bluestone (copper sulphate)...	4 level tablespoons or 4 pounds
Water..............................	2 quarts or 25 gallons
Hydrated lime........................	6 level tablespoons or 6 pounds
Water..............................	2 quarts or 25 gallons

Dissolve the pulverized bluestone in the water in an earthen or wooden vessel. (Bluestone is corrosive to some metals, particularly iron.) Place the hydrated lime in the second portion of water and stir it; then pour the bluestone solution into the limewater while stirring.

Bordeaux mixture should be made fresh for each application. If old bordeaux is applied it may cause injury to plants and result in unsatisfactory disease or insect control.

Combination Insecticides and Fungicides

Certain combination dusts and sprays may be made and thus control both insects and diseases at one application. For example, arsenical poisons may be added to bordeaux mixture, or both arsenicals and nicotine may be used in combination with bordeaux. To each 3 gallons of bordeaux 1 ounce of calcium arsenate or magnesium arsenate, or three-fourths ounce of paris green may be added. This gives a spray that will control certain leaf diseases and also the insects that eat the foliage. Bordeaux mixture is in itself a repellent for certain insects, and by the addition of 1 teaspoonful of nicotine sulphate to each gallon of bordeaux mixture, reasonable control of leaf hoppers and aphids can be secured in addition to the control of leaf blight.[1]

The stomach poisons, Paris green and calcium arsenate, are used to control the Colorado potato beetle. Two or three applications of this spray to the potato crop may be necessary. DDT (3 per cent solution or 3 per cent dust) is proving to be very effective in the control of the Colorado potato beetle, leaf

[1] For more detailed information on the control of garden diseases and insects consult *Farmers' Bulletin* 1371, "Diseases and Insects of Garden Vegetables."

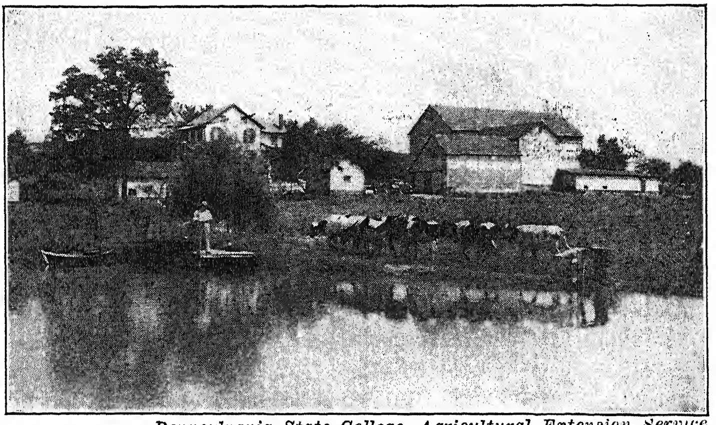
hoppers, and other insects that affect the potato. Its use may add several weeks of growth to early potatoes. The contact poisons, nicotine sulphate for example, are used in the control of aphids that affect cabbage plants, peas, radishes, spinach, beans, and other succulent plants. Spraying with a Bordeaux mixture is effective in the control of leaf hoppers and flea beetles of the potato. Beets, swiss chard, beans, and eggplant are protected by spraying with Bordeaux mixture. Bordeaux is also effective in controlling the early and late blight of potatoes, mildew of the onion, leaf spot of beets, chard, tomatoes, and eggplant, and the mildew or leaf spot of squashes, pumpkins, and melons. Usually several applications of spray or dust are necessary. An effective sprayer or duster is essential equipment for the growing of garden crops and fruits for the small garden. Hand dusters or the small type of compressed air sprayers are effective.

The use of DDT will not only control flies, moths, and other household insects but will also make the home yard much more available for family use through the control of flies and mosquitoes.

Food from the Fields, Woods, Ponds, and Streams. On the home farm, or in the neighborhood, game in some form is usually available, such as rabbits, squirrels, quail, pheasants, where legally permitted, and wild duck and other wild fowl in season. Opportunity for wholesome sport is provided, and welcome contributions find their way to the farm table. Attention to the feed supply and protective plantings for wild life and game will be rewarded by more available game animals and birds during the hunting season.

Planting the headlands of fields along woods or windbreaks with lespedeza, alfalfa, clovers, ladino, mixed with brome grass, redtop, orchard grass, and other grasses will furnish additional feed for wild life and a protective cover. Many farmers interested in game and wild life plant strip plantings of mixtures of soybeans, buckwheat, millet, sorghum, Sudan grass, lespedeza, sunflowers, rye, and wheat to furnish avail-

able feed throughout the year. Planting nut trees, haw trees, and other trees or shrubs producing edible fruits along the outside border of the farm woodlots and long windbreaks will provide valuable food and shelter for many forms of wild life. A little attention to the proper planting of wastelands to wildlife feed and cover crops will provide a source of pleasure and profit.



Pennsylvania State College, Agricultural Extension Service

The farm pond provides water for livestock, fire protection, irrigation, and recreation and fish for the farm family.

Farm stock-water and fish ponds are increasing rapidly in importance as sources of fish, frogs, muskrats and other fur-bearing animals, and wild ducks. Such farm ponds provide excellent opportunities for family picnics. Many state and federal agencies aid in the construction and stocking of such ponds with fish.

The Soil Conservation Service provides advice and surveys of the watershed and aids in planning the dam and spillways in dam construction and bank planting. Machinery for dam construction is made available in many localities. The Production and Marketing Administration pays awards for the

construction of stock-water and fish ponds in many states. State wild life and conservation departments aid in stocking the ponds with desirable fish and aquatic plants.

Fish and stock-water ponds should be fenced off so that livestock cannot muddy the water and kill bass and other fish and damage the dam spillway and banks. Gambusia minnows are usually planted to control mosquitoes and provide fish food.

The land bordering the pond, the earth dam, and the spillways should be planted with grass and legumes, and the banks with willows, evergreens, wild rose, and other trees and shrubs to furnish shade, protect the banks, and provide food and shelter for wild life. When filled with water, stocked with fish, and protected by bank planting, each pond becomes a haven for wild life. As much as possible of the drainage area above the pond should be kept in permanent pasture, in legumes and grasses in rotation, or in woodlot plantings. Water for livestock should be drawn through the dam into a watering trough outside the fenced area.

Usually state game conservation departments cooperate in the planting of the right kinds of fish. Bass, croppies, perch, bream, blue gills, sunfish, catfish, and, in some states, bullfrogs are made available. Pan fish can be taken one or two years after they are planted.

The fertilization of farm fish ponds with commercial fertilizer and lime greatly increases the production of fish. Complete commercial fertilizers such as a 4–12–4 or 4–10–6 at the rate of 800 pounds and 800 pounds of lime per acre are usually applied in two applications of 400 pounds each. The fertilizer and lime are spread by hand from the shore outward to outside water depths of 3 or 4 feet. At the Alabama Experiment Station, fish yields were increased more than 500 pounds per acre of pond by proper pond fertilization that increased the aquatic growth on which the fish fed.

Farm ponds, in addition to providing fish, furnish water for livestock, swimming, hunting, and fire protection; feed, water,

and protection for wild life; and picnic and recreation grounds for the farm family.

SUGGESTIONS

1. Secure bulletins from your State Extension Service and Experiment Station on the home farm garden and preserving garden products by canning, freezing, drying, and pit storage.

2. Take field trips to near-by home farm gardens at planting time and when garden crops are in use or being harvested.

3. Visit farms where stock-water and fish ponds and farm woodlots and windbreaks are successfully maintained.

4. Secure bulletins on woodlots and windbreaks and fish-ponds construction, stocking, and fertilizing from your Extension Service, Experiment Station, and Office of Publications of the United States Department of Agriculture.

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